

1 Overview

If a potential V is applied across some element in an electrical circuit, the current I in the element is determined by a quantity known as the resistance R . The relationship between these three quantities serves as a definition *resistance*; this relationship is

$$R = \frac{V}{I} \quad (1)$$

The resistance of any circuit element, whether it has other significant electrical properties or not, is given by the ratio of voltage to current as described in equation 1. For any given circuit element, the value of this ratio may change as the voltage and current changes. Nevertheless, the ratio of V to I defines the resistance of the circuit element at that particular voltage and current. The units of resistance are volt per ampere—this is called an ohm (Ω).

Certain circuit elements obey a relationship that is known as Ohm's law. For these elements, the quantity R is constant for different values of V and I . Therefore, in order to show that a circuit element obeys Ohm's law, it is necessary to vary the current in the circuit and measure the potential drop across the element.

The resistance of any object to electrical current is dependent on the material it is made out of, as well as the length, cross-sectional area, and temperature. The resistance is given by the expression

$$R = \rho \frac{\ell}{A} \quad (2)$$

where ℓ is the length, A is the cross-sectional area, and ρ is a material property called the *resistivity*. Note that the resistivity actually depends on temperature, and having current run through a wire causes its temperature to increase.

2 Materials

- Resistance coils. The gauge given for each wire is in Standard Wire Gauge (SWG).
- Ammeter. This must be connected in series with an element when you want to know the current through that element
- Voltmeter. This must be connected in parallel with an element when you want to know the voltage drop across that element
- DC power supply

The resistors will heat up and may be damaged by allowing current to flow through them for long periods of time; make measurements quickly and DO NOT LEAVE THE VOLTAGE TURNED UP WHEN DECIDING WHAT TO DO NEXT.

3 Tasks

- Show that each coil obeys Ohm's law, and report its resistance.
- Experimentally determine the resistivity of the first four coils. They are made of annealed copper, which has a resistivity of $1.72 \times 10^{-8} \Omega \cdot \text{m}$ at 20°C ; compare your results to this value.
- Identify the material the last coil is made out of. Be sure to cite any references you use.

Do not neglect to report and account for experimental uncertainties.