Unit B – Practical 6

Factors affecting resistance – a. Length of wire

Safety

Wires get **very hot** when current flows through them. You should place the wire on a heat-proof mat, never touch it during the experiment and minimise the time current flows through the wire.

Apparatus and materials

- constantan wire (1.25 m)
- micrometer
- sandpaper
- metre rule
- heat-proof tile
- connecting wires
- crocodile clips (2)
- ammeter and voltmeter (or two digital multimeters)
- power supply
- switch
- variable resistor

Introduction

According to the theory, the relationship that links electrical resistance with the shape and the material of the conductor is:

$$R = \rho \frac{L}{A}$$

where R is the electric resistance of the wire, L is the length of the wire, A is the cross-sectional area of the wire and ρ is the electrical resistivity of the material the wire is made of.

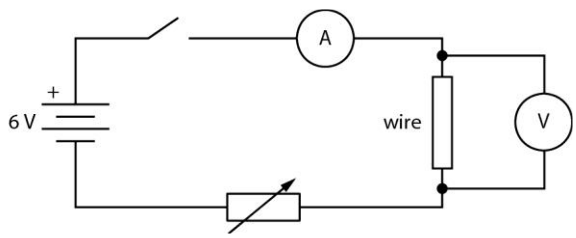
To measure the electrical resistance R of a conductor we measure the potential difference V across it and the current I flowing through it and calculate its resistance using $R = \frac{V}{I}$.

In this practical, you will construct a simple circuit to investigate the relationship between the length of a metal wire and its electrical resistance.

Procedure

1 Use sandpaper to remove any coating or oxides from the surface of the wire, ensuring electrical connection with the circuit.

2 Measure the diameter of the wire using the micrometer. Take several measurements from different points along the wire and calculate the average diameter of the wire.



3 Calculate the cross-sectional area of the wire A. (Be careful with the units!)

4 Construct the circuit shown in the diagram. Use the crocodile clips to connect the required length of wire to the circuit, without cutting the remaining length. The initial length selected should be 0.40 m

5 Set the variable resistor at its middle setting.

6 Place the circuit you constructed on the heat-proof tile.

7 The next step is to allow current to flow through the circuit (close the switch) and take measurements of *V* and *I*. You have to do this as quickly as possible to avoid any effect to your measurements.

8 Calculate the resistance.

9 Change the voltage across the wire using the variable resistor (rheostat) and calculate the resistance.

10 Repeat for three more values of *V* and record your measurements and calculations in a suitable table.

11 Find the average value of resistance.

12 Repeat the process (steps **4**–**11**) changing the length of the wire between the crocodile clips to 0.60 m, 0.80 m, 1.00 m and 1.20 m.

13 Plot a graph of electrical resistance against length of wire.

14 Draw a best-fit line for your points and calculate its gradient.

15 According to the theoretical equation ($R = \rho \frac{L}{A}$), the gradient should be equal to $\frac{\rho}{A}$. Use the value of the gradient to calculate the experimental value of the electrical resistivity ρ of the material of the wire.

16 Compare this experimental value of ρ with the accepted value (for constantan, $\rho = 4.9 \times 10^{-7}\ \Omega\,\text{m}$).

Questions

1 If you were not quick in taking the measurements of *V* and *I*, how would these measurements be affected?

2 What are the percentage uncertainties of *L*, *V*, *I* and *R* for each length of the wire?

3 How will you calculate the percentage uncertainty in the value of ρ?