Investigation to determine the resistivity of a metal

Introduction

In this experiment, you will measure the current through different lengths of a metal wire. You will then determine the resistivity of the metal wire.

The p.d., *V,* across the wire is related to the length, *L,* of the wire by the expression

$$\frac{V}{I} = \frac{\rho L}{A}$$

where I, ρ and A are constants for the experiment. I is the current in the wire, ρ is the resistivity of the wire and A is the cross sectional area of the wire.

This expression may also be written as

$$V = \frac{\rho I}{A} \times L$$

Aim

- To determine the resistivity of a metal

Intended class time

- 60 to 90 minutes

Equipment (per group)

- switch, S
- 1 m length of resistance wire
- micrometer or vernier caliper
- 2 crocodile clips
- 7 connecting leads
- 1 d.c. power supply or battery pack and rheostat connected as a potential divider (centres may also use a variable power supply if available)
- voltmeter
- ammeter
- rheostat

Health and safety

The metal wire may get hot.

Record your planned procedure to minimise this hazard and get it authorised by your teacher before proceeding with the experiment.

Procedure

1. Set up the circuit shown below in Fig. 1, so that the d.c. supply is in series with an external switch, S, and the metal wire. The length of wire in the circuit is adjusted and connected into the circuit using crocodile clips.

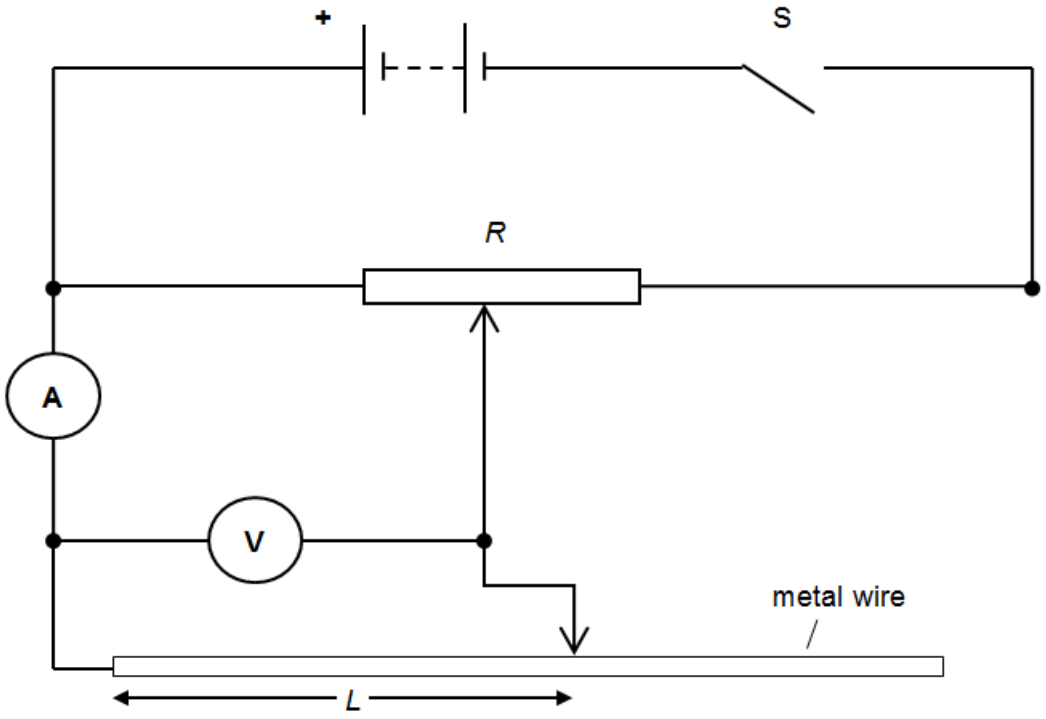

Fig. 1

2. Connect the circuit as shown above.
3. Adjust the length, *L*, of wire in the circuit so that it is 50.0 cm.
4. Close the switch, S, and adjust the power supply or potential divider so that the reading on the voltmeter is 3.0 V.
5. Note the reading on the ammeter. This must be kept constant throughout the experiment.
6. Record the reading on both the ammeter and voltmeter for a range of different lengths of the metal wire. (Remember, the ammeter reading should always be the same.)
7. Tabulate your data in a table.
8. Plot a graph of *V* against *L*.
9. Determine the gradient of your graph.
10. By taking appropriate measurements, determine the diameter of the metal wire.
11. Calculate the cross-sectional area, *A*, of the metal wire.
12. Use your answers to steps 4, 5 and 10 to determine a value for the resistivity.

Extension Opportunities

Using the uncertainty in your measurements for the p.d. across the wire and the length of the wire add range bars to your graph and draw a worst acceptable fit line.

Determine the uncertainty in your gradient.

Determine the uncertainty in the measurement of the diameter and hence in the measurement of the cross-sectional area.

Give a final answer for the resistivity of the metal wire with a tolerance within which there is confidence that the value lies.

Research a value for the resistivity of the metal wire you have been given. Quote your sources.

Calculate the percentage difference between your value for the resistivity and the researched value and comment on the accuracy of your experiment.

Explain how the value for the resistivity would have been different if the p.d. had been kept constant and the variation of current with length had been measured.

Recording

As evidence for the Practical Endorsement you should have the data collected from your group in a clear and logical format. All work should be clearly dated.

In addition, in preparation for the assessment of practical work in the written examinations and to help develop your understanding of physics, you should have used the data collected to calculate a value for the resistivity, explaining clearly how you have used the data in each calculation and showing all working.

You should also be able to calculate the percentage difference between your calculated values and the value from your research.