### Resistance of a Wire

Materials can be classed as either electrical *conductors* or *insulators*. Insulators block or hinder the flow of electrons through them … they ‘resist’ the flow of current. Another name for them is ‘resistors’ and that’s where this term comes from

At a constant temperature the resistance of a particular material depends on:

* the length of the material ( *l* )
* the cross-sectional area (CSA) of the material (determined by its thickness)
* the ‘resistivity’ (or ‘block-ability’) of the material

*l*

**CSA**

**Equipment required**

* nichrome wire to be tested
* digital multimeter
* digital micrometer
* metre rule or tape measure

**Method**

In order to test how the resistance of a particular material is related to its length and cross sectional area, an experiment in two parts must be conducted. The first part has the length as the independent variable with all other variables controlled; the second has the cross sectional area as the independent variable with all other variables controlled. Both quantities cannot be tested at once.

**Part A – testing length *l***

Choose four different lengths of the same wire. Measure the resistance of each length with the multimeter.

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| length, *l* (m) | 0 |  |  |  |  |
| resistance, R (Ω) | 0 |  |  |  |  |

**Part B – testing CSA**

Perform a similar experiment to produce a table of diameter, *d* and resistance, *R* for constant wire length. Note: cross sectional area = π r2 = π d2 ÷ 4

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| diameter, *d* (m) |  |  |  |  |
| cross sectional area, CSA (m2) |  |  |  |  |
| resistance, *R* (Ω) |  |  |  |  |

**Analysis – Part A**

Plot a graph resistance, *R* on the *y*-axis versus length, *l* on the *x*-axis.

1. Give your graph a title.

2. Join your points with a line of best fit (trendline).

3. What does your graph indicate about the relationship between length and resistance for constant cross sectional area?

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**Analysis – Part B**

Plot a graph resistance, *R* on the *y*-axis versus cross sectional area, CSA on the *x*-axis.

4. Give your graph a title.

5. Join your points with a line of best fit (trendline).

6. What does your graph indicate about the relationship between length and resistance for constant cross sectional area?

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Georg Ohm discovered that the resistance of a material is directly proportional to its length and inversely proportional to its cross-sectional area. This means that longer wires should have more resistance and shorter wires have less resistance. Also, thicker wires have less resistance and thinner wires have more resistance.

7. Is this what you found from your graphs?

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**Resistivity**

The resistance of a given piece of material can be said to be:

Resistivity has the symbol ‘ρ’ which looks like a ‘p’ but is actually the Greek letter rho which has the modern sound of an ‘r’. Rearranging the formula to make ρ the subject gives:

Resistivity is measured in ohm metres (Ω m). For nichrome wire it has the value of 100 × 10−8Ω m. For copper which is a very good conductor it has a value of 1.7 × 10−8Ω m.

8. Do you think nichrome is as good a conductor as copper? Why or why not?

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9. Why do you think thicker wires have less resistance? (Think about how easy or hard it is for electrons to find a way through the material)

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10. Why do you think longer wires have more resistance?

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