**The resistivity of conducting putty**

This experiment is based on the following equation: 

Where R is the resistance of a conductor

 *ρ* is the resistivity of the material

 *l* is the length of the conductor

and A is the cross-sectional area

This is an experiment where the analysis proves to be difficult! The resistivity of the putty is a constant, but the resistance of a length of putty depends on two variables, length and cross-sectional area, therefore we need to investigate these separately.

**Variation of R with length**

The putty is rolled into a ‘sausage’ of roughly circular cross-section. The diameter of the putty is measured 3 times giving 16 mm, 17 mm and 15 mm. The following results are obtained for resistance against length.

|  |  |  |
| --- | --- | --- |
| *l* / cm |  | R / Ω |
| 2 |  | 4.5 |
| 3 |  | 6.6 |
| 4 |  | 8.4 |
| 5 |  | 10.3 |
| 6 |  | 12.5 |
| 7 |  | 14.2 |
| 8 |  | 16.5 |
| 9 |  | 18.4 |
| 10 |  | 20.6 |

Complete the middle column with values of length in metres and then plot a graph with resistance on the y-axis and length on the x-axis. Measure and record in the space below the gradient of the best fit straight line. Don’t forget to include a unit.

…………………………………………………………………………………………………………………………………………………………….

The gradient of this line is NOT the resistivity. To match the equation with ‘y = mx + c”, we re-write it as  and it can be seen that the gradient is *ρ/A.*

The value of *ρ* is found from *ρ =* gradient x *A.* Calculate the average radius of the putty ‘sausage’, then use this to find the cross-sectional area (πr2) of the putty. You can then use this value and the gradient to work out a value for the resistivity in Ω m.

…………………………………………………………………………………………………………………………………………………………….

…………………………………………………………………………………………………………………………………………………………….

Looking at the equation for resistivity, the graph should not have an intercept. Does your graph pass through the origin? If not, measure the intercept. Thinking about the experimental procedure, can you explain the origin of this systematic error?

…………………………………………………………………………………………………………………………………………………………….

…………………………………………………………………………………………………………………………………………………………….

**Variation of R with cross-sectional area**

To do this part, the putty is made into a cuboid and the resistance is measured across a fixed length of 3.0 cm. The height of the block is kept at a constant 2.0 cm, but the width, w is changed by cutting pieces off. The following table of results is obtained.

|  |  |  |  |
| --- | --- | --- | --- |
| w / cm | A / m2 | 1/A / m-2 | R / Ω |
| 6.0 |  |  | 1.3 |
| 5.0 |  |  | 1.4 |
| 4.0 |  |  | 1.8 |
| 3.0 |  |  | 2.1 |
| 2.0 |  |  | 3.4 |

Note the resistance goes up as the area is reduced, so we need to plot a graph of resistance against 1 / area. Complete the columns of A and 1 / A, being careful to convert to S.I. units. Now plot the graph with R on the y-axis and 1 / A on the x-axis and measure and record below the gradient. Don’t forget to include the appropriate S.I. unit for the gradient.

…………………………………………………………………………………………………………………………………………………………….

If the equation is now re-written as  we can see that the gradient is *ρl*.

Use your gradient value and the length of the putty block to find a second value for the resistivity of putty.

…………………………………………………………………………………………………………………………………………………………….

…………………………………………………………………………………………………………………………………………………………….

You now have two experimental values for the resistivity of conducting putty. The final part of the analysis is to compare these two results. What is the most appropriate value to put in the denominator of a percentage difference calculation?

…………………………………………………………………………………………………………………………………………………………….

Calculate the percentage difference between your 2 values.

…………………………………………………………………………………………………………………………………………………………….