

Physics

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Higher Level

2020-21

Mandatory Experiment - Measuring the resistivity of nichrome wire



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Below is a question from the 2000 Leaving Cert exam, based on one of the mandatory experiments. This experiment was asked in 2004 and again in 2009. It would not be surprising if this experiment was asked next June.

Sample question 5: In an experiment to measure the resistivity of nichrome wire the following data were obtained

| | | | | | |
|-------------------------------|------|------|------|------|------|
| Resistance of wire / Ω | 8 | | | | |
| Length of wire / cm | 60.4 | | | | |
| Micrometer reading / mm | 0.34 | 0.32 | 0.35 | 0.36 | 0.32 |

- Explain why several readings of the micrometer were taken.
- The reading on the micrometer when it was fully closed was 0.02 mm. Taking this into account, calculate the average diameter of the wire.
- Calculate a value for the resistivity of the wire
- The three quantities measured in this experiment were resistance, length and diameter. Which of these quantities was **measured least accurately**? Explain your answer and give one way in which the accuracy of this quantity could be improved.

Solution:

Note that part (a) of the question was asked also in 2004. Should this be asked again you would know exactly what to write as an answer. The key words being non-uniform, average and accuracy.

- (a) The micrometer measures diameter and the diameter could be **non-uniform**. Several readings allows for an **average** to be calculated which improves the **accuracy** of the experiment.

Part (b) contains a clever little numerical trick on the idea of the zero error.

- (b) The micrometer has a zero error of 0.02 mm. Subtract this from all the readings and then calculate the average.

$$\begin{aligned} \text{Average diameter} &= \\ \frac{0.32 + 0.30 + 0.33 + 0.34 + 0.30}{5} &= 0.318 \text{ mm} \end{aligned}$$

Part (c) is the main mathematical part of the question. This is the very same as the mathematical parts of the 2004 and the 2009 questions. Knowing how to deal with this question greatly adds to your confidence and knowing during the exam that your answer is correct is a nice feeling.

(c)

$$\begin{aligned} \rho &= \frac{A R}{l} = \frac{\pi r^2 \times R}{l} \\ \rho &= \frac{\pi \times (0.159 \times 10^{-3})^2 \times 8}{0.604} \\ \rho &= 1.05 \times 10^{-6} \Omega m \end{aligned}$$

Part (d) contains a trick question that could apply to any of the mandatory experiments. Knowing how to handle this would be a great addition to your knowledge for the exam.

(d)

- Resistance was measured least accurately.
- The reason is that the value of resistance was only given to **one significant figure**.
- The accuracy of the resistance value would be improved by using a more sensitive ohmmeter, one that would read to the first place of decimals.