Resistivity practical and data analysis worksheet

AQA AS 7407 and first-year A Level 7408 | OCR A AS H156 and A Level H556

35–40 minutes independent practice + 15–20 minutes review | 41 marks

Specification points covered

AQA 7407 / 7408: 3.5.1.3 selected resistivity and metal-wire investigation (Required practical 5); 3.1.2 selected uncertainty and experimental error.
OCR A H156 / H556: 4.2.4(a)(i)–(ii); 1.1.3(d)(i)–(ii), 1.1.4(d)–(e), selected graph analysis, uncertainty and experimental improvement.

Northline precision-wire quality control must verify the resistivity of thin metal wire for temperature-sensor production. Use a measured resistance–length trend to obtain the material property and evaluate whether the measurement method protects its validity. The graph and uncertainty work use the same wire throughout.

1. Planning the wire measurements [5 marks]

Northline varies the tested length of one uniform wire to determine its resistivity at a controlled temperature.

(a) State the relation between resistance R, resistivity ρ, length L and cross-sectional area A. State the SI unit of ρ. [2 marks]

(b) The factory varies the tested length of one wire. State the independent variable, the dependent variable and two quantities that should be controlled. [3 marks]

2. Circuit, temperature and dimensions [9 marks]

Use low-voltage equipment and a small current to avoid appreciably changing the test-wire temperature.

(a) Draw a complete circuit for measuring the p.d. across and current through a chosen length of the test wire. Include a low-voltage d.c. supply, switch, ammeter, voltmeter and variable resistor. [3 marks]

(b) Explain how the variable resistor and switch help to keep the wire at an approximately constant temperature. [2 marks]

(c) Describe how the separation of the electrical contact points should be measured accurately. [2 marks]

(d) Describe how a micrometer should be used to obtain a reliable mean diameter for the wire. [2 marks]

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3. Diameter evidence and uncertainty [5 marks]

The micrometer has resolution 0.001 mm. Remeasurement confirms that one table entry is a recording error, not a real thick section of wire.

Position along wire / m	Diameter in direction 1 / mm	Diameter in direction 2 / mm
0.10	0.381	0.379
0.45	0.380	0.382
0.80	0.378	0.445

(a) Identify the anomalous diameter in the table. Calculate the mean from the remaining values, then calculate the cross-sectional area. [3 marks]

(b) Treat the uncertainty in mean diameter as ±0.001 mm. Calculate the percentage uncertainty in diameter and hence the approximate percentage uncertainty in area. [2 marks]

4. Resistance data [2 marks]

The factory records paired voltage and current readings for seven contact separations. The two resistance entries marked with a dash are to be completed.

Length L / m	p.d. V / V	Current I / A	Resistance R / Ω
0.20	0.212	0.200	1.06
0.30	0.297	0.198	—
0.40	0.392	0.202	1.94
0.50	0.476	0.200	2.38
0.60	0.557	0.197	2.83
0.70	0.647	0.198	—
0.80	0.734	0.198	3.71

(a) Use R = V/I to calculate the two missing resistance values in the results table. Give each to two decimal places. [2 marks]

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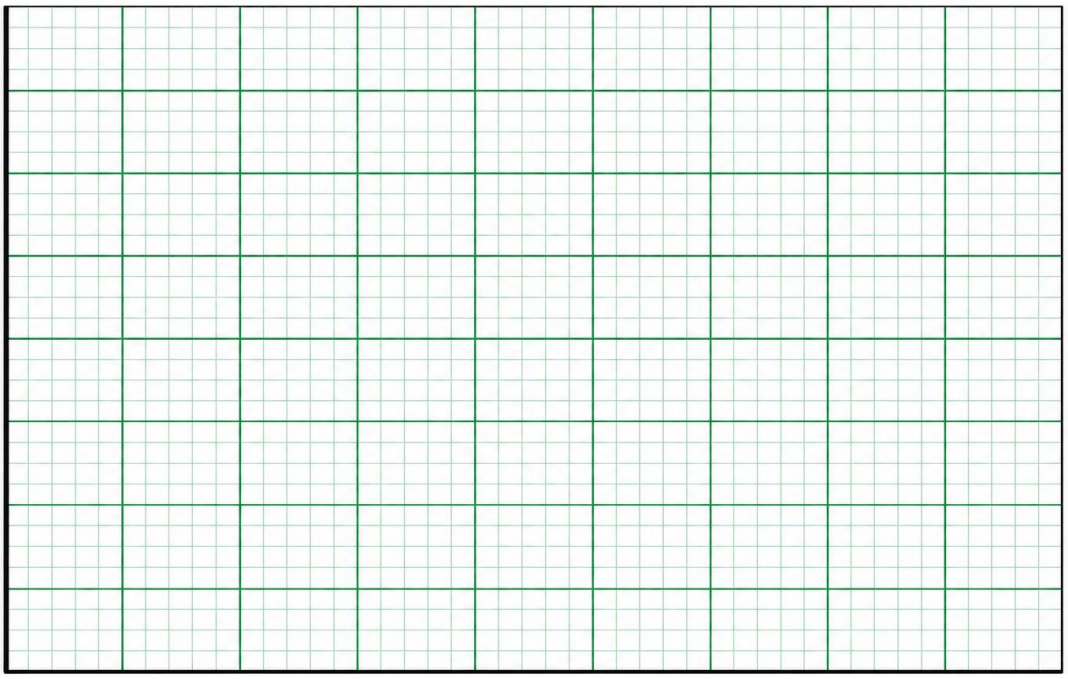
5. Graph and gradient [5 marks]

Use all seven completed resistance values from Question 4.



(a) On the graph grid, label the horizontal axis length L from 0.0 to 0.9 m and the vertical axis resistance R from 0.0 to 4.0 Ω. Plot all seven points and draw a straight line of best fit. [3 marks]

(b) Use two well-separated points on your line of best fit to determine its gradient, including a unit. [2 marks]

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6. Resistivity and the intercept [6 marks]

A small resistance offset may be present in the test rig. Use the gradient, not a single resistance/length ratio.

(a) Use your graph gradient and the mean area from Question 3(a) to determine the wire resistivity. [2 marks]

(b) The line of best fit has a small positive intercept on the resistance axis. Explain one likely cause and why the gradient method still gives a valid wire resistivity. [2 marks]

(c) For this calculation use gradient = (4.41 ± 0.10) Ω m^{-1}. Estimate the percentage and absolute uncertainty in resistivity, using the area uncertainty from Question 3(b). [2 marks]

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7. Evaluation and complete method [9 marks]

Recommend a repeatable quality-control procedure for the same wire material.

(a) Suggest three specific improvements that would increase the quality of the resistivity result. For each, state the problem it reduces. [3 marks]

(b) Write a complete six-mark-style method for determining the resistivity of the wire. Use the prompts: circuit and controls; length and diameter measurements; repeated V and I readings; graph and gradient; calculation of ρ; uncertainty and evaluation. [6 marks]

Review: measure between electrical contacts; obtain ρ from the gradient times the mean cross-sectional area; link every improvement to an uncertainty or systematic effect.

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