

Solutions

Original-task allocations: B1 = one point, M1 = one method mark, A1 = one accuracy mark.

2.1 Direct proportionality requires a straight line through the origin. A positive intercept gives non-zero extrapolated resistance at zero measured wire length. Fixed contact/lead resistance is a possible cause.

2.2 $m = \Delta R / \Delta l = (4.50 - 1.30) / (1.00 - 0.20) = 4.00 \, \Omega \text{ m}^{-1}$. $c = R - ml = 1.30 - 4.00 \times 0.20 = 0.50 \, \Omega$. $\rho = mA = 4.00 \times 1.2 \times 10^{-7} = 4.8 \times 10^{-7} \, \Omega \text{ m}$.

2.3 $\Delta\rho = (0.9/100) \times 8.90 = 0.0801 \, \text{g cm}^{-3}$. Interval about 8.82 to 8.98 g cm^{-3} . 8.94 is inside, so the measurement is consistent with it; this does not uniquely prove composition.

3.1 Correct orientation, quantity/unit labels and regular scales filling a useful part of the grid. All five points accurately plotted. Thin straight best-fit line balancing scatter. Large triangle using well-separated points on the fitted line. Gradient about $4.0 \, \Omega \text{ m}^{-1}$, accepting about 3.9–4.1 from a sensible fit. A larger triangle reduces percentage coordinate-reading uncertainty in the changes.

3.2 The SI gradient is $2.30 \times 10^3 \times 10^6 = 2.30 \times 10^9 \, \text{Hz}$. The model gives $v = \lambda \times \text{gradient}$. $v = 650 \times 10^{-9} \times 2.30 \times 10^9 = 1.50 \times 10^3 \, \text{m s}^{-1}$. Ignoring MHz produces an answer too small by a million.

3.3 Take additional readings at smaller resistance intervals around the indicated maximum. Keep source conditions steady, limiting current/heating and checking repeated readings for drift. Use the fitted curve/scatter rather than declaring one point exact. Advantage: maximum external power available for transmission. Disadvantage: large internal heating/only 50% source efficiency, wasting energy and needing cooling.