

A Level Physics A

H556/02 Exploring physics

Question Set 25

1 (a) State Kirchhoff's second law and the physical quantity that is conserved according to this law.

Around a closed loop, sum of e.m.f.s = sum of p.d.s. (conservation of energy). [2]

(b) The S.I. base units for the ohm (Ω) are $\text{kg m}^2 \text{s}^{-3} \text{A}^{-2}$.

Use the equation $R = \frac{\rho L}{A}$ to determine the S.I. base units for resistivity ρ .

$$\rho = \frac{AR}{L}$$

base units for ρ $\text{kg m}^3 \text{s}^{-3} \text{A}^{-2}$ [2]

$$\left. \begin{array}{l} A = \text{m}^2 \\ R = \text{kg m}^2 \text{s}^{-3} \text{A}^{-2} \\ L = \text{m} \end{array} \right\} \rho = \frac{\text{kg m}^4 \text{s}^{-3} \text{A}^{-2}}{\text{m}} = \text{kg m}^3 \text{s}^{-3} \text{A}^{-2}$$

- (c) Fig. 18.1 shows a circuit used by a student to determine the resistivity of the material of a wire.

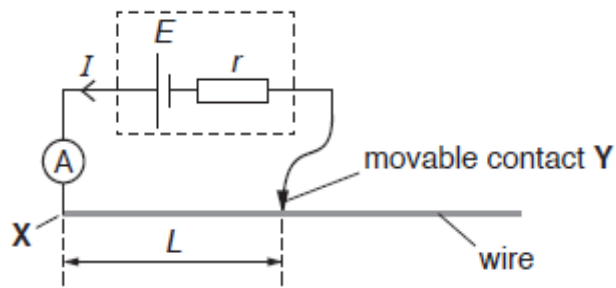


Fig. 18.1

The wire is uniform and has diameter 0.38 mm. The cell has electromotive force (e.m.f.) E and internal resistance r . The length of the wire between X and Y is L .

The student varies the length L and measures the current I in the circuit for each length.

Fig. 18.2 shows the data points plotted by the student.

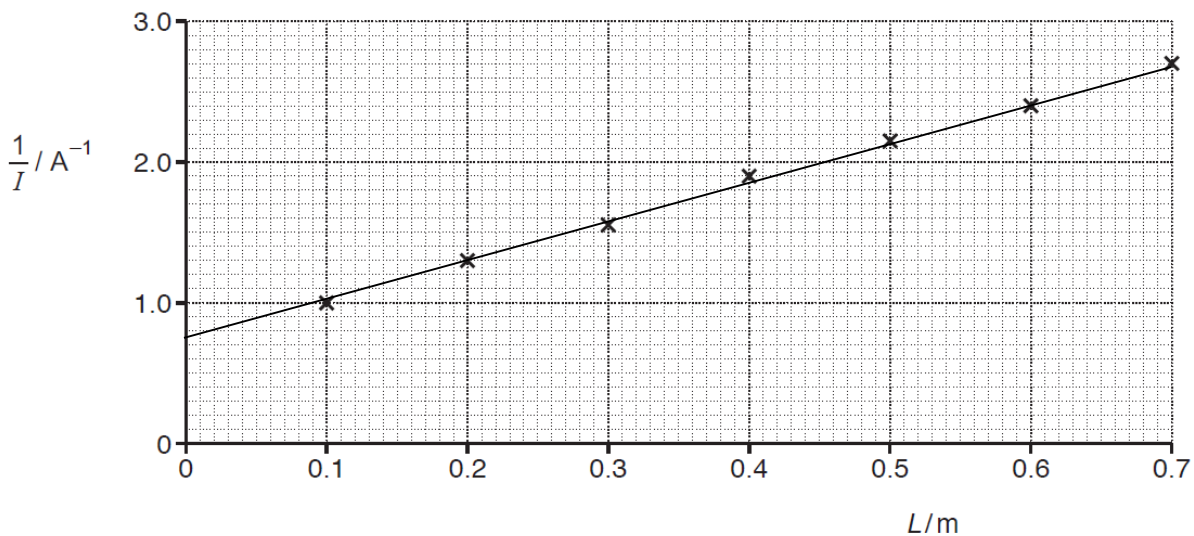


Fig. 18.2

- (i) On Fig. 18.2 draw the straight line of best fit. Determine the gradient of this line.

$$\text{gradient} = \frac{2.7 - 0.8}{0.7} = 2.7 \quad \text{gradient} = \dots\dots\dots 2.7 \dots\dots\dots \text{A}^{-1}\text{m}^{-1} \text{ [2]}$$

- (ii) Show that the gradient of the line is $\frac{\rho}{AE}$, where ρ is the resistivity of the material of the wire, A is the area of cross-section of the wire and E is the e.m.f. of the cell.

$$R = \frac{\rho L}{A} \quad \text{and} \quad E = IR \Rightarrow \frac{E}{I} = \frac{\rho L}{A} \Rightarrow \frac{1}{I} = \frac{\rho L}{AE} \quad \text{in form } y = mx \quad \text{where } m = \frac{\rho}{AE} \quad [2]$$

- (iii) The e.m.f. E of the cell is 1.5V. The diameter of the wire is 0.38 mm.

Use your answer to (i) and the equation given in (ii) to determine ρ .

$$2.7 = \frac{\rho}{1.5 \times \pi (0.38 \times 10^{-3})^2} \Rightarrow \rho = 1.8 \times 10^{-6} \quad \rho = \dots\dots\dots 1.8 \times 10^{-6} \Omega\text{m} \quad [2]$$

- (iv) Fig. 18.3 illustrates how the student had incorrectly measured all the lengths L of the wire.

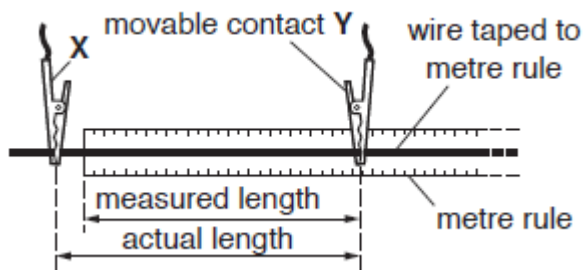


Fig. 18.3

According to the student, re-plotting the data points using the **actual** lengths of the wire will not affect the value of the resistivity obtained in (iii).

Explain why the student is correct.

- Because gradient = $\frac{\rho}{AE}$ is independent of L [2]
- It will just translate the graph, but not change the gradient.

Total Marks for Question Set 25: 12

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