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.fs = sum of p.d.s. Conservation of energy. **[2]**

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

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

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

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

$A = m^2$

$R = kgm^2s^{-3}A^{-2}$

$L = m$

$\rho = \frac{kgm^4s^{-3}A^{-2}}{m} = kgm^3s^{-3}A^{-2}$

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

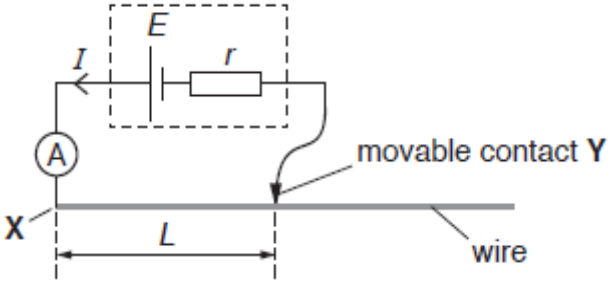

Fig. 18.1

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.

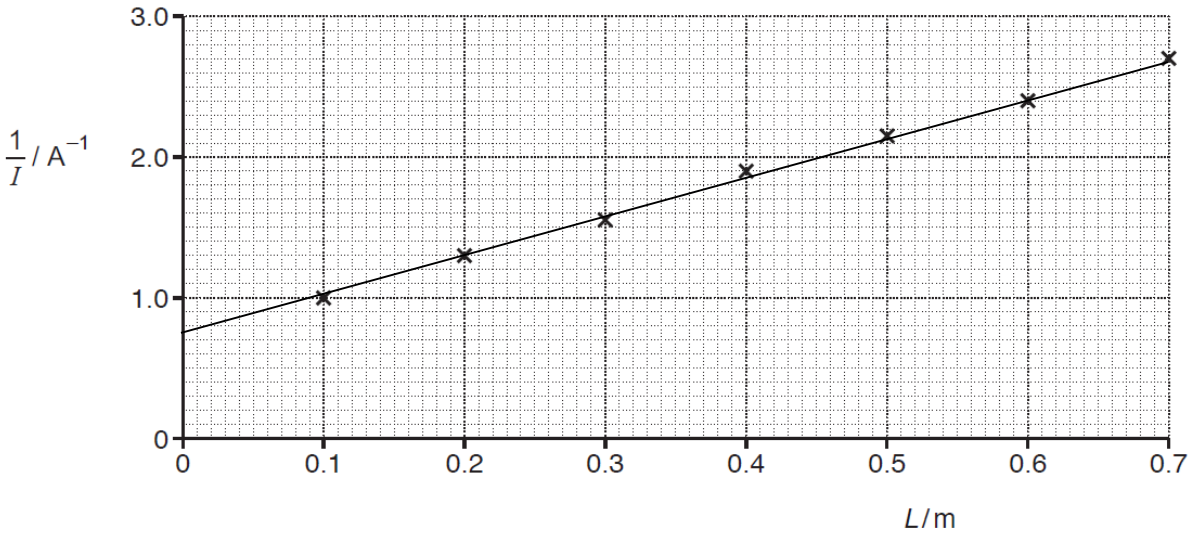

Fig. 18.2

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

gradient = $\frac{2.7 - 0.8}{0.7} = 2.7$

gradient = 2.7 $A^{-1}\,m^{-1}$ **[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.

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

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

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

$2.7 = \frac{\rho}{1.5 \times \pi (0.38 \times 10^{-3})^2} \Rightarrow \rho = 1.8 \times 10^{-6}$

ρ = ... 1.8×10^{-6} ..... Ωm **[2]**

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

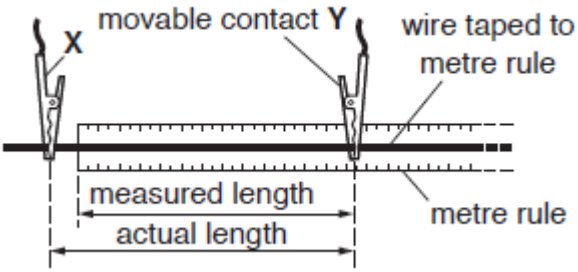

Fig. 18.3

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. **[2]**

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

Total Marks for Question Set 25: 12