

# **A Level Physics A**

**H556/02** Exploring physics

## **Question Set 4**

1 (a) State **one** S.I. base quantity other than length, mass and time.

Temperature / Current / Light Intensity ..... [1]

(b) Fig. 17 shows two resistors **X** and **Y** connected in series.



Fig. 17

The resistors are wires. Both wires have the same length  $L$  and diameter  $d$ . The material of **X** has resistivity  $\rho$  and the material of **Y** has resistivity  $2\rho$ .

(i) Show that the total resistance  $R$  of the wires is given by the equation

$$R = \frac{12\rho L}{\pi d^2}$$

$$R = \frac{\rho L}{A} \quad \text{and} \quad A = \pi \left(\frac{d}{2}\right)^2 \quad [2]$$

$$\text{Combining we get} \rightarrow R = \frac{4\rho L}{\pi d^2}$$

$$\rho \text{ of X} = \rho \quad \text{and} \quad \rho \text{ of Y} = 2\rho$$

$$\rightarrow R_X = \frac{4\rho L}{\pi d^2} \rightarrow R_Y = \frac{8\rho L}{\pi d^2}$$

$$\rightarrow R_{\text{Total}} = R_X + R_Y \quad \text{because in series}$$

$$\rightarrow R_{\text{Total}} = \frac{4\rho L}{\pi d^2} + \frac{8\rho L}{\pi d^2} = \frac{12\rho L}{\pi d^2}$$

(ii) A student uses the equation in (i) to determine  $R$ .  
The table below shows the data recorded by the student in her lab book.

Quantity	Value
$\rho$	$4.7 \times 10^{-7} \Omega \text{ m}$
$L$	$9.5 \pm 0.1 \text{ cm}$
$d$	$0.270 \pm 0.003 \text{ mm}$

1. Name the likely instruments used by the student to measure  $L$  and  $d$ .

$L$ : Ruler .....

$d$ : Micrometer .....

[1]

2. Use the data in the table and the equation in (i) to determine  $R$  and the absolute uncertainty. Write your answer to the correct number of significant figures.

$$R = \frac{12PL}{\pi d^2} = \frac{12 \times 4.7 \times 10^{-7} \times 9.5 \times 10^{-2}}{\pi \times (0.27 \times 10^{-3})^2} = 2.34$$

$$\text{relative uncertainty of } L = \frac{0.1}{9.5} = 0.0105$$

$$\text{relative uncertainty of } d = \frac{0.003}{0.27} = 0.011$$

$$\text{relative uncertainty of } R = \frac{0.1}{9.5} + \left( 2 \times \frac{0.003}{0.27} \right) = 0.0327$$

$$\text{absolute uncertainty of } R = 0.0327 \times 2.34 = 0.0766 \approx 0.1$$

$$\underline{\underline{2.3 \pm 0.1 \Omega}}$$

$$R = \dots 2.3 \dots \pm \dots 0.1 \dots \Omega \quad [4]$$

3. The instrument used to measure  $d$  has a zero-error. The measured  $d$  is much **larger** than the actual value.  
Discuss how the actual value of  $R$  compares with the value calculated above.

Actual  $R$  is large because actual  $d$  is smaller and  $R \propto 1/d^2$  [1]

**Total Marks for Question Set 4: 9**

1. (b) (i)

1. (b) (ii) 2.

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