

- 4 A student had two pieces of constantan wire, X and Y.

Wires X and Y had different diameters.

- (a) The student measured the diameter  $d_x$  of wire X several times using a micrometer screw gauge.

- (i) Explain one measuring technique he should use.

(2)

- (ii) The student recorded the following measurements.

$d_x / \text{mm}$	0.31	0.32	0.31	0.33	0.30
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Determine the mean value of  $d_x$  and its uncertainty in mm.

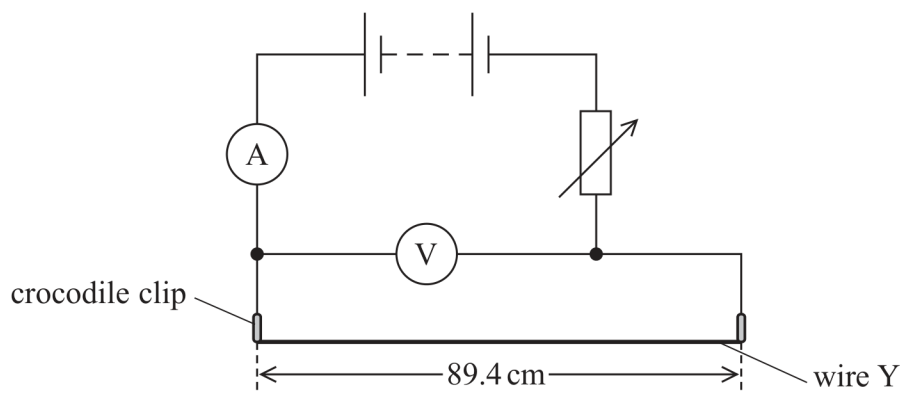
(3)

Mean value of  $d_x = \dots \text{mm} \pm \dots \text{mm}$



(b) The student measured the diameter  $d_Y$  of wire Y as  $0.22 \text{ mm} \pm 0.01 \text{ mm}$ .

He connected part of wire Y in a circuit as shown.



The student measured the potential difference  $V$  across the wire in the circuit and the current  $I$  in the wire.

He recorded the following values

$$V = 4.990 \text{ V} \pm 0.005 \text{ V}$$

$$I = 0.4570 \text{ A} \pm 0.0005 \text{ A}$$

The length of wire Y in the circuit was  $89.4 \text{ cm} \pm 0.1 \text{ cm}$ .

(i) Show that the resistivity  $\rho$  of the metal is about  $5 \times 10^{-7} \Omega \text{ m}$ .

(3)

(ii) Show that the percentage uncertainty in  $\rho$  is about 9%.

(3)

- (c) The student measured the resistances  $R_1$  and  $R_2$  of different lengths of wire Y using an ohmmeter. Each resistance was measured once.

The student's values are given in the table.

	Length / cm	Resistance / $\Omega$
$R_1$	40.0	4.5
$R_2$	90.0	10.2

He calculated the resistance  $R_L$  for one metre of wire using the formula

$$R_L = 2 \times (R_2 - R_1)$$

Show that the percentage uncertainty in  $R_L$  is about 2%.

$$R_L = 11.4 \Omega$$

(3)

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- (d) The student wanted to confirm that the metal of the wire is constantan.

The student compared his calculated values of  $\rho$  and  $R_L$  to published values for constantan.

The values are shown in the table below.

	$\rho / 10^{-7} \Omega \text{ m}$	$R_L / \Omega$
Calculated	$4.6 \pm 9\%$	$11.4 \pm 2\%$
Published	4.9	11.2

Comment on how well the student's calculated values confirm that the metal of the wire is constant.

You must include calculations in your answer.

(3)

(Total for Question 4 = 17 marks)