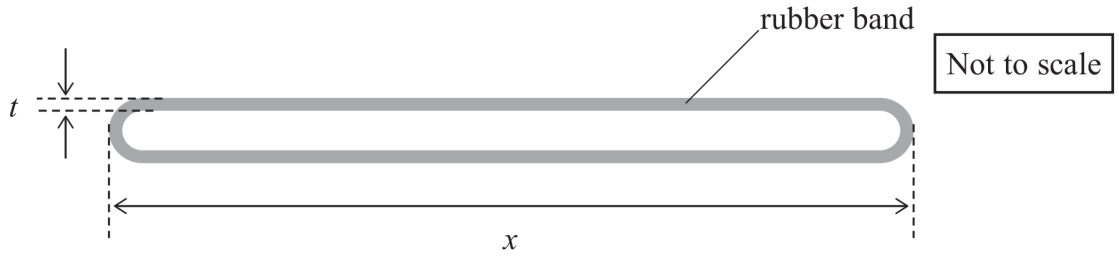
4 A student made measurements on a rubber band as shown.



The rubber band has a rectangular cross-section.

(a) The student used a micrometer screw gauge to measure the thickness t.

(i) Explain **one** technique she should use to measure t.

(2)

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(ii) The student recorded the following measurements.

***t* / mm**	1.02	1.06	1.05	1.01

Calculate the mean value of t in mm.

(1)

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Mean value of t = ... mm

(iii) Determine the percentage uncertainty in t.

(2)

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Percentage uncertainty in t = ...

(iv) Folding the rubber band and measuring the total thickness of four layers would reduce the percentage uncertainty in t.

Explain the effect of folding the rubber band on the percentage uncertainty in t.

(2)

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(v) The student used a metre rule to measure the length x and used the micrometer screw gauge to measure the width w of the rubber band.

She determined the volume of the rubber band using the formula

$$V = 2xwt$$

Suggest **two** reasons why the calculated volume may **not** be accurate.

(2)

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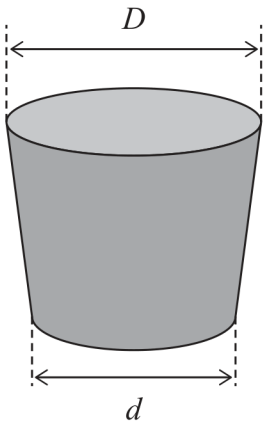
(b) The student made measurements on a rubber bung as shown.



Not to scale

The average cross-sectional area A of the bung is given by

$$A = \frac{\pi}{12}(D^2 + d^2 + Dd)$$

(i) Show that the uncertainty in D^2 is about $0.07\,\text{cm}^2$.

$D = 3.45\,\text{cm} \pm 0.01\,\text{cm}$

(2)

(ii) Show that the uncertainty in A is about $0.05\,\text{cm}^2$.

$d^2 = 9.36\,\text{cm}^2 \pm 0.06\,\text{cm}^2$
$Dd = 10.56\,\text{cm}^2 \pm 0.07\,\text{cm}^2$

(2)

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(c) The student determined the density of the rubber band and the density of the rubber bung. She also determined the corresponding percentage uncertainty in each value, as shown.

	Rubber band	**Rubber bung**
Density / g cm^{-3}	1.15	1.52
Percentage uncertainty	4.3	1.2

Deduce whether the rubber band and the rubber bung could be made of the same type of rubber.

(3)

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(Total for Question 4 = 16 marks)