

4 A cylindrical container is made from a transparent material. Two students want to determine the density of this material.

- (a) The students need to make measurements to determine the volume of the transparent material. The external diameter of the container is approximately 10 cm.

Student A suggests measuring the external diameter with a metre rule.

Student B suggests placing a piece of string around the circumference of the container and then measuring this length of string with a metre rule.

Explain which of these measurements would have the least percentage uncertainty.

(2)

- (b) The students decide to use string to determine the circumference of the container. They measure the thickness t of the string using a micrometer screw gauge.

- (i) Explain **two** techniques that could be used to make sure this measurement is as accurate as possible.

(2)



(ii) The following measurements were obtained.

| t / mm | | | | |
|-----------------|------|------|------|------|
| 2.15 | 2.06 | 2.13 | 2.08 | 2.10 |

Calculate the mean value of t in mm and its uncertainty.

(2)

mean $t = \dots\dots\dots \text{mm} \pm \dots\dots\dots \text{mm}$

(c) The circumference C of the container can be determined using the formula

$$C = x - \pi t$$

where x is the length of string around the container.

(i) Calculate the value of C in cm.

$$x = 25.8 \text{ cm} \pm 0.2 \text{ cm}$$

(2)

$C = \dots\dots\dots \text{cm}$

(ii) Show that the uncertainty in C is approximately 0.2 cm.

(1)



(d) The volume V of the transparent material is given by

$$V = \frac{C^2 L}{4\pi} - V_i$$

where L is the length of the container and V_i is the internal volume of the container.

Determine the value of V in cm^3 and its uncertainty.

$$L = 19.90 \text{ cm} \pm 0.05 \text{ cm}$$

$$V_i = 810 \text{ cm}^3 \pm 5 \text{ cm}^3$$

(4)

$$V = \dots\dots\dots \text{cm}^3 \pm \dots\dots\dots \text{cm}^3$$



- (e) The table shows the densities of some common materials used to manufacture this type of container. Only borosilicate is safe to heat directly with a Bunsen burner.

| Material | Soda glass | Borosilicate | Perspex |
|---------------------------|------------|--------------|---------|
| $\rho / \text{g cm}^{-3}$ | 2.52 | 2.23 | 1.18 |

The mass of the container was measured as $463 \text{ g} \pm 1 \text{ g}$.

Deduce whether the container is safe to heat directly with a Bunsen burner.

(4)