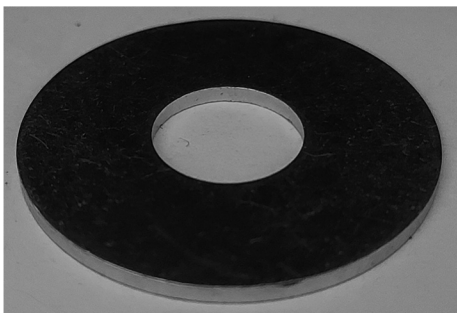


- 4 A student measured a metal ring of the type shown below.



- (a) The student measured the diameter d of the hole in the centre of the metal ring with a set of digital calipers.

- (i) Explain one technique she should use to reduce the uncertainty in the measurement of d .

(2)

- (ii) She recorded the following measurements.

d/mm	8.53	8.56	8.55	8.53
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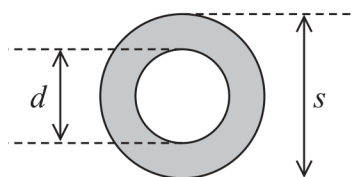
Determine the mean value of d and its uncertainty in mm.

(3)

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



- (b) The student was given a metal ring of a different size. She measured the distances shown.



She calculated the shaded area A of the metal using the formula

$$A = \frac{\pi}{4}(s^2 - d^2)$$

- (i) Show that the uncertainty in d^2 is about 1 mm^2 .

$$d = 10.70 \text{ mm} \pm 0.06 \text{ mm}$$

(3)

- (ii) Show that the percentage uncertainty in A is about 0.4%.

$$s^2 = 881 \text{ mm}^2 \pm 2 \text{ mm}^2$$

(4)



- (c) The student measured the total mass m_{10} of 10 identical metal rings as 63 g.

Explain why measuring the total mass of 10 metal rings is better than measuring the mass of one metal ring.

(2)

- (d) She measured the total thickness x_{10} of a stack of these 10 metal rings.

- (i) Determine the mean density ρ , in g cm^{-3} , of the metal the ring is made from.

$$m_{10} = 63.0 \text{ g} \pm 0.5 \text{ g}$$

$$x_{10} = 14.03 \text{ mm} \pm 0.04 \text{ mm}$$

$$A = 602 \text{ mm}^2 \pm 0.4\%$$

(2)

$$\rho = \dots\dots\dots \text{g cm}^{-3}$$

- (ii) The density of stainless steel ranges from 7.48 g cm^{-3} to 7.95 g cm^{-3} .

Deduce whether the metal rings could be made from stainless steel.

(3)