

Units, prefixes and reliable measurements

Physics grades 9-10 (GCSE · IGCSE · O Level · Class 9-10) · Lab answers

The model answers use the sample table. Your own values will differ slightly, but the pattern should be the same: the tallest stack gives the smallest percentage uncertainty.

Level: Physics grades 9-10 (GCSE · IGCSE · O Level · Class 9-10) · **Curriculum:** GCSE WS, IGCSE 1.1

Question 1 Thickness of one sheet

1. $2.2 \div 20 = \mathbf{0.110 \text{ mm}}$; $4.1 \div 40 = \mathbf{0.103 \text{ mm}}$; $6.3 \div 60 = \mathbf{0.105 \text{ mm}}$; $8.0 \div 80 = \mathbf{0.100 \text{ mm}}$; $10.2 \div 100 = \mathbf{0.102 \text{ mm}}$.

2. Mean = $(0.110 + 0.1025 + 0.105 + 0.100 + 0.102) \div 5 = 0.5195 \div 5 = \mathbf{0.104 \text{ mm}}$.

Question 2 Percentage uncertainty

20 sheets: $0.5 \div 2.2 \times 100 = \mathbf{23 \%}$.

100 sheets: $0.5 \div 10.2 \times 100 = \mathbf{4.9 \%}$.

Question 3 Choosing the best stack

The reading error of $\pm 0.5 \text{ mm}$ is the same for every stack, but it is a much smaller fraction of a tall stack. The 100-sheet stack has a percentage uncertainty of **about 5 %**, against 23 % for 20 sheets, so it gives the most reliable value.

Question 4 Graph and gradient

The points lie close to a straight line through the origin: the height is directly proportional to N. Gradient = $10.2 \text{ mm} \div 100 \text{ sheets} = \mathbf{0.102 \text{ mm per sheet}}$.

Question 5 Metres in standard form

$0.102 \text{ mm} = 0.102 \times 10^{-3} \text{ m} = \mathbf{1.02 \times 10^{-4} \text{ m}}$.

Question 6 Checking against a reference

5 % of 0.102 mm is 0.005 mm, so the result is $0.102 \pm 0.005 \text{ mm}$, which spans 0.097 to 0.107 mm. The micrometer value of 0.10 mm lies inside this range, so the two results **agree**.

Question 7 Improving the method

1. Use a micrometer on the stack, or a stack of 500 sheets, to cut the percentage uncertainty.
2. Press every stack with the same book for the same time, and check the ruler has no worn end, to avoid a **systematic error**.