

Units, prefixes and reliable measurements

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

Name: _____ Date: _____ Class: _____

Paper is far too thin for a ruler to read directly. This lab shows how stacking many sheets turns a tiny length into a measurable one, and why a larger stack shrinks the percentage uncertainty of the result.

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

Aim

To measure the thickness of one sheet of paper, far smaller than a ruler can read, by measuring stacks of different sizes, and to see how uncertainty depends on the size of the stack.

Equipment

- About 100 sheets of the same copier paper
- 30 cm ruler with millimetre marks
- Heavy book to press the stack flat
- Calculator and graph paper

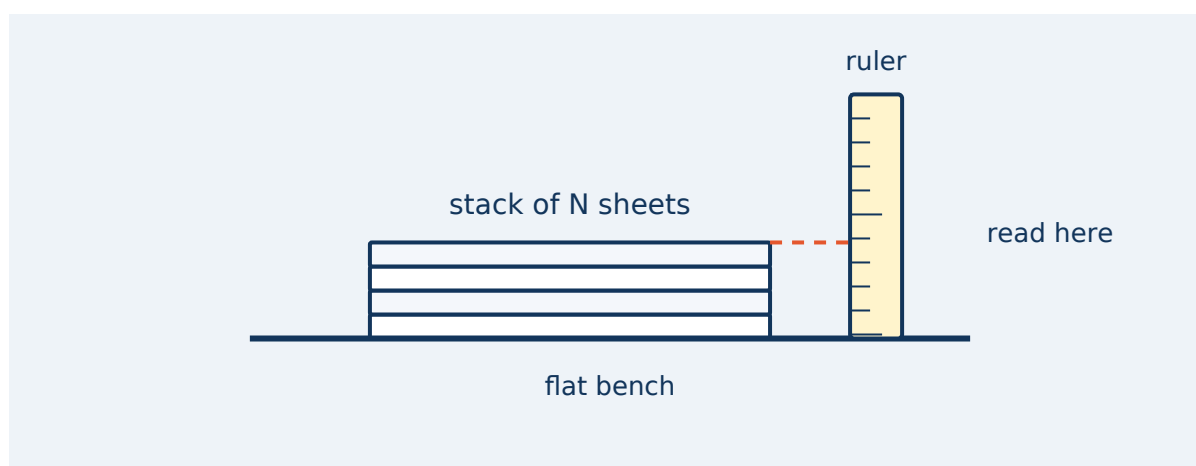
Safety

Safety

Paper edges can give small cuts. Handle sheets by the faces and keep the stack away from the edge of the bench so nothing falls.

Method

1. Count out a stack of 20 sheets and square up the edges on a flat bench.
2. Place the book on top for 10 seconds, then remove it and stand the ruler beside the stack.
3. Read the height of the stack at eye level to the nearest 0.5 mm and record it.
4. Repeat with 40, 60, 80 and 100 sheets, pressing each stack in the same way.



Set-up: the stack is squared up, pressed flat and measured beside a ruler.

Results

Sample measurements taken by a student:

Number of sheets, N	Height of stack (mm)
20	2.2
40	4.1
60	6.3
80	8.0
100	10.2

Analysis questions

Question 1 Thickness of one sheet

1. Calculate the thickness of one sheet for each stack, to 3 decimal places.
2. Calculate the mean of the five values.

Question 2 Percentage uncertainty

Each height has an uncertainty of ± 0.5 mm. Calculate the percentage uncertainty for the 20-sheet stack and for the 100-sheet stack.

Question 3 Choosing the best stack

Explain why the 100-sheet stack gives the best value for the thickness of one sheet.

Question 4 Graph and gradient

Describe the graph of stack height against N and use the point N = 100 to find its gradient.

Question 5 Metres in standard form

Write the thickness of one sheet from the gradient in metres, in standard form.

Question 6 Checking against a reference

A micrometer gives 0.10 mm for one sheet. Decide whether your result agrees with it, using the uncertainty of the 100-sheet stack.

Question 7 Improving the method

Suggest two improvements that would reduce the uncertainty or the systematic error.