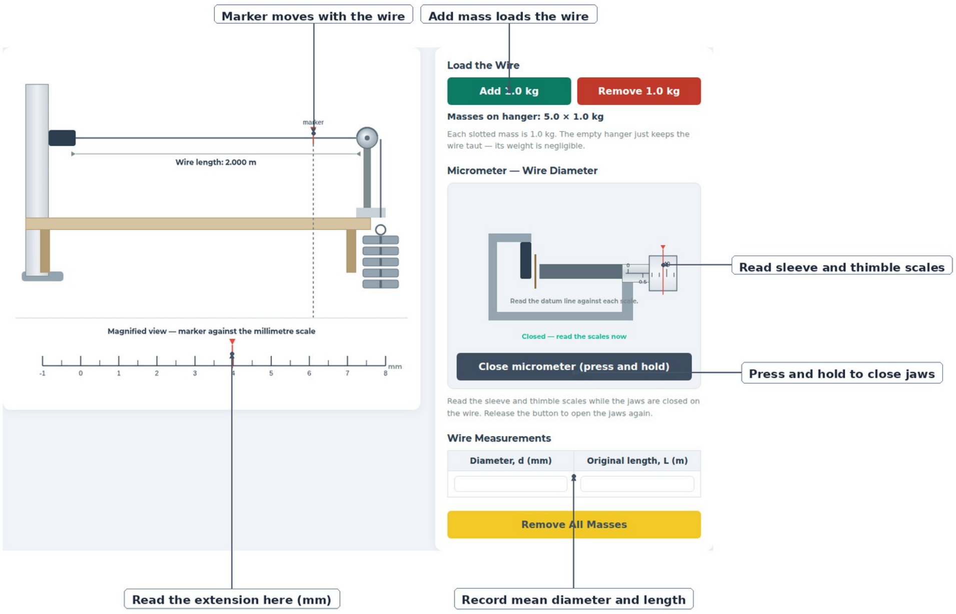
Young's Modulus of a Wire

Extension, Load and the Stiffness of a Wire

Aim:

You are investigating how the load on a wire affects its extension, then using your results to find the Young modulus of the wire's material.



Prediction:

Add a single 1.0 kg mass to the hanger and watch the marker on the magnified scale.

Do you predict its movement will be easily visible, or too small to see without magnification? ....

Test it in the simulation.

Method:

1. With no masses on the hanger, note where the marker sits on the magnified scale — this is your zero reading.
2. Press and hold the Close micrometer button to close the jaws on the wire. Read the diameter from the sleeve and thimble scales. Repeat this five times without moving the wire, recording each reading.
3. Find the mean of your five diameter readings. Record it, together with the wire's stated length read from the bench label, in the wire measurements table.
4. Add masses to the hanger one at a time, in 1.0 kg steps up to 8.0 kg. At each step, read the extension of the wire from the magnified scale to the nearest 0.1 mm, and record the load and extension in your results table.
5. Remove all the masses using Remove All Masses and check that the marker returns to its starting position.

Diameter readings:

1) .... mm 2) .... mm 3) .... mm 4) .... mm 5) .... mm Mean: .... mm

Wire measurements:

Diameter, d (mm)	Original length, L (m)

Results:

#	Load (kg)	Force, F (N)	Extension, x (mm)	Stress (Pa)	Strain

Analysis:

Plot a graph of extension (mm) against load (kg). Describe the shape of your graph.

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cross-sectional area (m^2) = π × (diameter (m))^2 / 4

stress (Pa) = force (N) / cross-sectional area (m^2) **strain = extension (m) / original length (m)**

Use your mean diameter to find the cross-sectional area of the wire, then calculate the force (take $g = 10\ N\ kg^{-1}$), stress and strain for each load. Watch your unit conversions — the scale reads millimetres. Complete the remaining columns of your results table.

Plot a graph of stress (Pa) against strain, and draw a line of best fit through the straight part of your data. Find the gradient of your line, including its unit. What physical quantity have you just measured?

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Explaining why:

Look at your five diameter readings and their spread. Estimate the uncertainty in your mean diameter, and express it as a percentage of the mean.

Your calculation of the cross-sectional area uses the diameter twice, because it is squared. What effect does this have on the percentage uncertainty in the area, compared with the diameter's own percentage uncertainty?

Considering your diameter readings and your extension readings together, which measurement do you think limits the accuracy of your final Young modulus value? Suggest one change of equipment or technique that would reduce it.