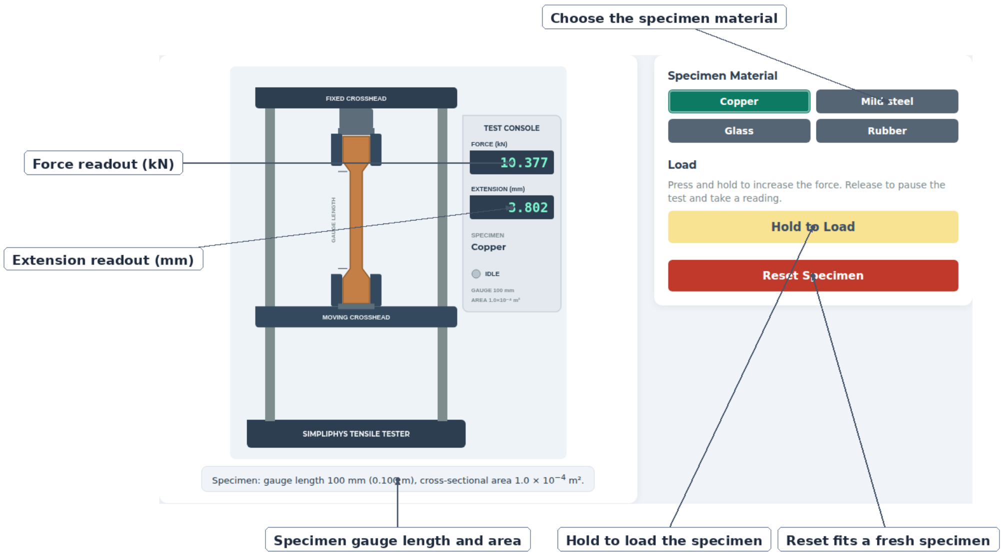
Stress-Strain Explorer

How Different Materials Stretch and Fail

Aim:

You are investigating how the material of a specimen affects the way it stretches and fails under load.



Prediction:

Look at the four material buttons: copper, mild steel, glass and rubber.

Which do you predict will stretch the furthest before it fails, and which will fail with the least warning? ....

Try loading each one briefly to test your prediction before you start taking careful readings.

Method:

1. Select Copper. Hold Load in short bursts, reading and recording the force and extension each time you pause, until the specimen fails.
2. Click Reset Specimen, then repeat for Mild steel, Glass and Rubber, recording at least four force-extension pairs for each material before it fails.
3. For each material, note how the specimen actually failed — did it neck, shatter, or snap?

Results:

#	Material	Force, F (kN)	Extension, x (mm)	Stress (Pa)	Strain

Analysis:

For each material, use your stress and strain values to sketch a rough stress-strain curve on the same axes. Which materials show a long stretch before they fail, and which fail suddenly with little warning?

stress (Pa) = force (N) / cross-sectional area (m²) **strain = extension (m) / original length (m)**

Use the specimen area (1.0×10^{-4} m²) and gauge length (0.100 m) given on the apparatus to calculate stress and strain for every reading, and complete the remaining columns of your results table.

For each material, use the straight-line part of your data to find the gradient of a stress-strain graph. What physical quantity does this gradient represent?

From your table, find — for each material — the stress at which the graph stops being straight, and, where the specimen has one, the highest stress it reached before failure. Rank the four materials from stiffest to least stiff, and from strongest to weakest, using your own figures.

Explaining why:

Glass shows no plastic region at all before it fails. What does this mean for how safe glass is to use in a structure that might accidentally be overloaded?

Mild steel and copper both neck visibly before they fracture. Why might this visible warning matter in engineering design, compared with a material like glass?

Suggest one application where you would deliberately choose rubber's stretching behaviour, and one where you would deliberately avoid a material that gives no warning before it fails.