

DETERMINATION OF YOUNG MODULUS OF A METAL IN THE FORM OF A WIRE

Specification reference: AS Unit 1.5 - Solids under stress

Theory:

Young modulus $E = \frac{\text{Stress}}{\text{Strain}}$ or $E = \frac{F/A}{x/l}$ rearranging $E = \frac{Fl}{xA}$

F = applied load

A = area of cross-section of the wire

x = extension

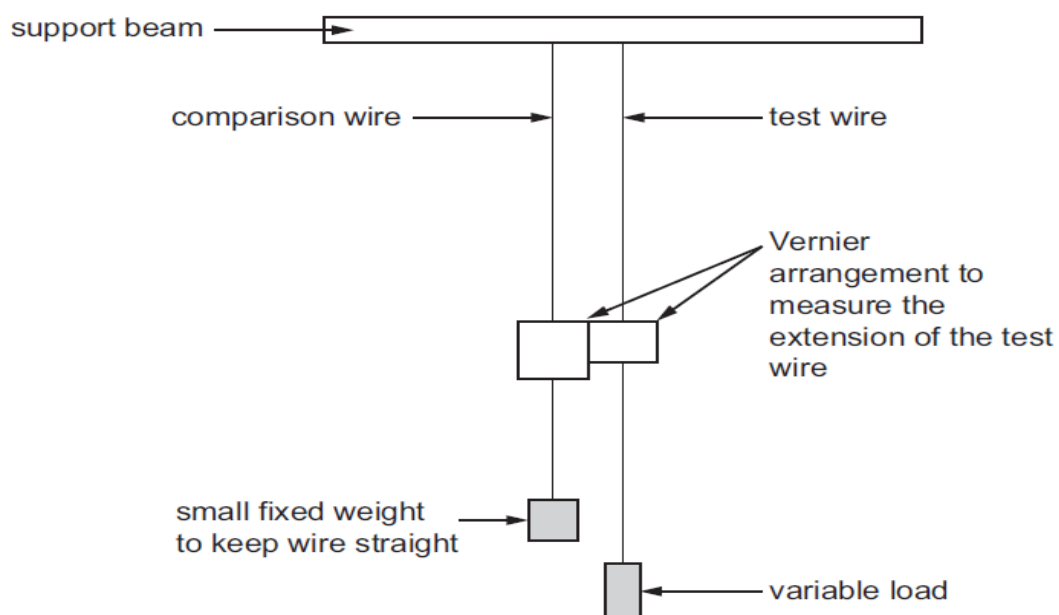
l = original length

If a graph of applied load, F (y-axis) is drawn against extension, x (x-axis) the gradient is $\frac{F}{x}$ and so:

$$E = \text{gradient} \times \frac{l}{A}$$

The original length l can be measured and the area of the wire found using $A = \pi r^2$ hence E can be determined.

Apparatus:



Further guidance for technicians:

The wires are usually steel and should be as long as is convenient, typically up to 2 metres and also as thin as possible in order to obtain a measurable extension. A micrometer will also be needed to measure the diameter of the wire. Suggested loads could be up to 60 N in 5 N steps.

Experimental Method:

Hang two identical wires from a beam and attach a scale to the first wire and a small weight to keep it straight. Also put a small weight on the second wire to straighten it and a Vernier scale linking with the scale on the comparison wire. Measure the original length, l , of the test wire and its diameter at various points along its length. Use this to calculate the mean cross-sectional area A .

Then place a load of 5 N on the test wire and find the extension, x . Repeat this in 5 N steps up to at least 50 N. Plot a graph of load (y -axis) against extension (x -axis) and calculate the gradient. Use this to find a value for the Young modulus.

Extension:

By comparing the Young modulus to known constants it would be possible to determine the type of metal the wire was made from.

Practical Techniques:

- Use appropriate analogue apparatus to record a range of measurements (to include length/distance, temperature, pressure, force, angles, volume) and to interpolate between scale markings.
- Use calipers and micrometers for small distances, using digital or vernier scales.
- Use ICT such as computer modelling, or data logger with a variety of sensors to collect data, or use of software to process data.

Relevant previous practical past papers:

- PH3 2005 Q3
- PH6 2012 Experimental task