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

Specification reference: **AS Component** **1.5 - Solids under stress**
A level Component **2.5 - Solids under stress**

Theory:

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

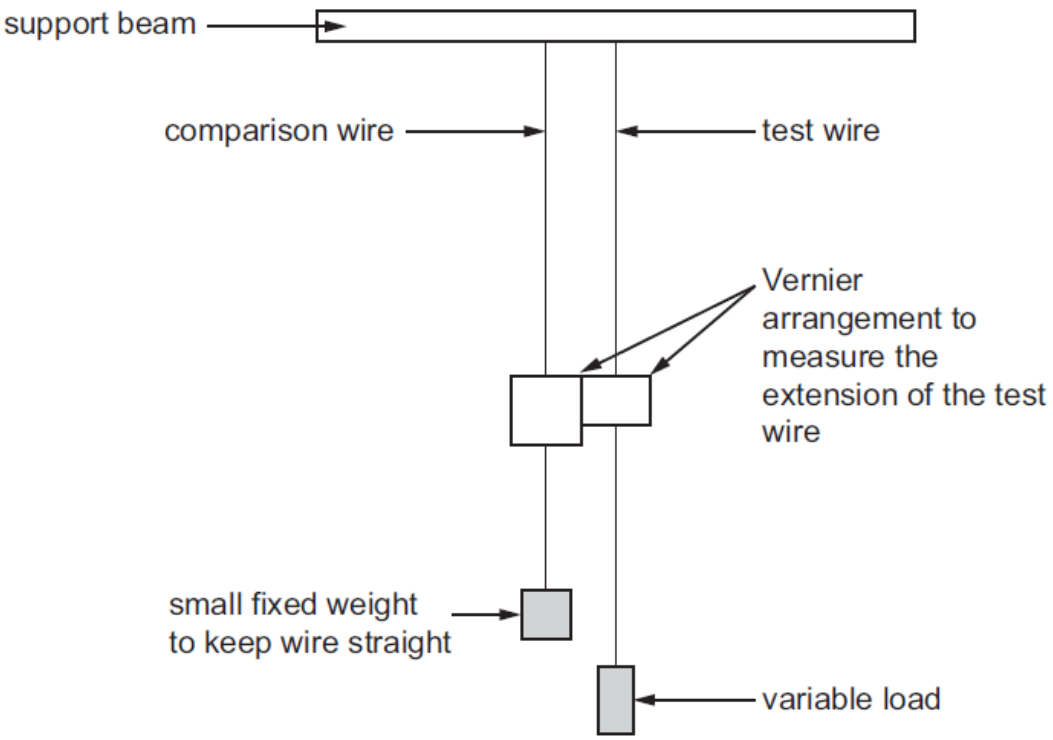
F = applied load
A = area of cross-section of the wire
x = extension
l = original length

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