WJEC England Physics A Level

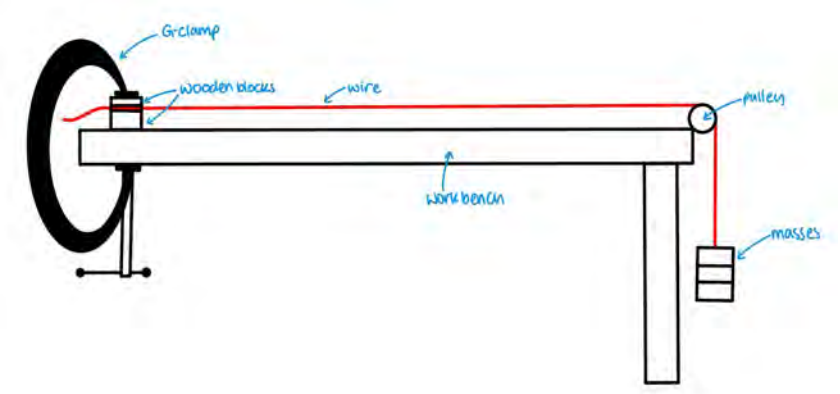
SP C1 05 : Solids Under Stress

Practical notes

1. Determination of Young Modulus of a Metal in the Form of a Wire

Equipment:

- G-clamp
- Wooden blocks
- Long copper wire
- Tape
- Metre ruler
- Work bench
- 100 g masses
- Pulley

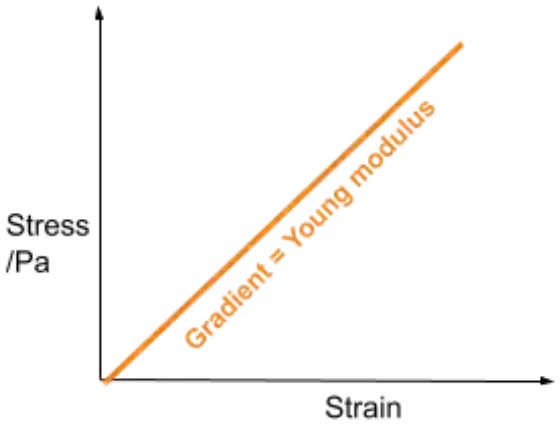


Method:

1. Measure the diameter of the wire in 3 different places using a micrometer and record these values (how to use a micrometer is illustrated below).
2. Set up the apparatus as shown in the diagram.
3. Attach the metre ruler to the workbench so that the lower end is facing the G-clamp and place a marker on the wire at 0 cm on the ruler.
4. Measure the length of wire from the blocks of wood to the marker on the wire when it is taut.
5. Attach a mass to the wire and record the total mass attached to the end of the wire in kg. The wire will stretch when this mass increases therefore, record the new position of the marker.
6. Add another 100 g mass and once again record the position of the marker - keep doing this until you have readings for at least 7 different mass values.

Calculations:

- Find the mean diameter of the wire and calculate the average cross sectional area using
  $A = \frac{\pi d^2}{4}$
- Using F = mg calculate the force exerted on the wire for each mass and record these values in a table.
- Calculate the wire's extension by finding the difference between the marker's final position and its initial position for each mass.
- Find the **stress** for each mass by dividing the force applied by the cross sectional area of the wire.
- Find the **strain** on the wire for each mass by dividing the extension ΔL by the original length of the wire.
- Plot a graph of stress against strain and draw a line of best fit.
- As the Young modulus = stress/strain, the gradient of the line of best fit is equal to the Young modulus of copper.



Safety:

- You MUST wear protective eyewear, as if the wire snaps and flies out it could seriously injure or blind people near it.
- Place some cushioning under the masses in case the wire snaps, so that they will not bounce and hit people's feet if they fall.

Notes:

- Make the original length of the wire as long as possible since this will reduce the uncertainty in the measurement of original length.
- Make sure the wire is relatively thin because the thinner the wire, the larger the extension it experiences. A larger extension will reduce the uncertainty in the measurement of extension.
- Try and find the extension for as many masses as possible as more data points allows a better line of best fit to be drawn.

2. Investigation of the Force-Extension Relationship for Rubber

Equipment:

- Clamp stand
- Metre rule
- G-clamp
- Micrometer
- Mass holder and 50g masses
- Rubber band with a cross section of around 1mm by 2mm
- Optical pin

Method:

1. Hang the piece of rubber band from the clamp stand.
2. Secure the clamp stand onto the workbench using a G-clamp.
3. Hang the mass hanger from the end of the rubber band.
4. Attach an optical pin to the base of the mass hanger - this will be used to take measurements from.
5. Place the metre rule as close to the mass hanger as possible and record the starting reading.
6. Record the length, width and thickness of the band whilst it supports the mass hanger - use a micrometer to measure the thickness, but take care not to squash it in the jaws.
7. Add further masses in 50g intervals until the rubber snaps, and calculate the extension each time (new reading - initial reading).
8. Plot a force-extension graph and calculate the Young Modulus for the linear region.

Safety:

- Falling masses may cause injury. Wear appropriate footwear and take care not to stand under the hanging masses.
- Ensure the clamp stand is securely clamped to the desk to avoid it tipping and causing injury
- Wear eye protection when using rubber bands.

How to Read a Micrometer:

1. Place the object to be measured between the jaw of the micrometer.
2. The barrel of the micrometer has two scales, one which is horizontal (barrel scale) and one which is vertical (thimble scale). The barrel scale will give a reading of millimeters and half millimeters.
3. Read the barrel scale by looking at the edge of the micrometer thimble (this is the part that turns), if the thimble is over the 4^{th} millimeter marking after 10 mm, you're

reading 14 mm and if it is on/just over the half millimeter making after 14mm, then the reading is 14.5 mm.

4. For more precise measurements, find where the thimble scale lines up exactly with the axis of the barrel scale. Each mark on the thimble scale represents 0.01 of a mm. If this is 33 then add 0.33 to the barrel scale reading (14.5 mm) to find the measurement is 14.83 mm.

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