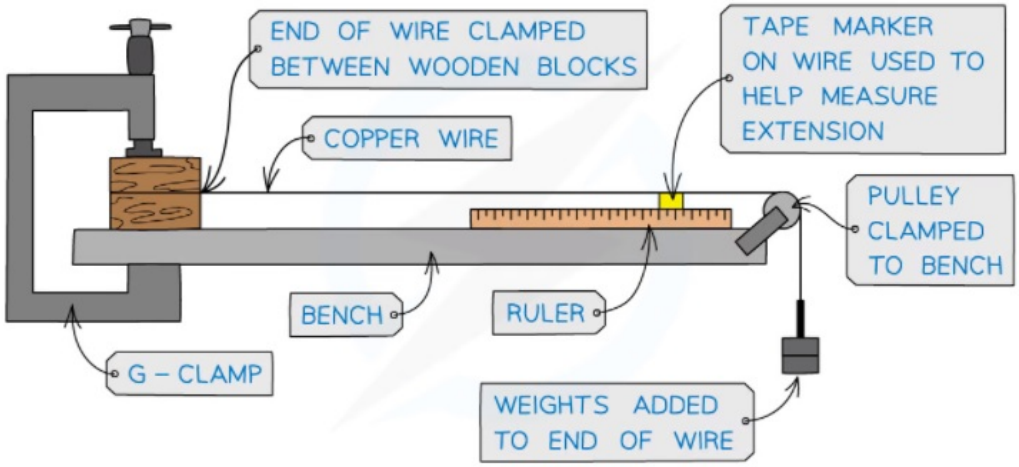
Young Modulus Practical

Formulas

1. Young Modulus $E = \frac{\sigma}{\epsilon}$ $\left(\frac{stress}{strain}\right)$
2. Stress $\sigma = \frac{F}{A}$ $\left(\frac{force}{area}\right)$
3. Strain $\epsilon = \frac{x}{L}$ $\left(\frac{change\ in\ length}{length}\right)$
4. Weight $W = mg$ $(mass \times gravity)$

Method

1. Attach pulley at edge of desk
2. Trap one end of copper wire between 2 wooden blocks 3m away from pulley
3. Pass wire through pulley and attach mass hanger
4. Measure diameter d of wire
5. Place meter ruler under wire and add sticky label to a point. This is the point you will be measuring the extension of.
6. Measure length of wire L from wooden blocks to sticky label
7. Add different masses and measure the extension of the wire



Making sure everything is accurate

1. In step 4, measure the diameter in 5 places and take the average
2. Longer wire will produce a longer extension so less uncertainty in measurement
3. In step 6 and 7, when measuring the lengths make sure to look vertically down over the sticky label and use a set square to make the measurement. This helps avoid parallax error
4. Don't add masses that are too high otherwise there will be creep occuring. Creep is basically permanent deformation of the material.
5. For more data points before the elastic limit of the wire use weights increasing in smaller increments. (25g, 50g, 75g instead of 100g, 200g, 300g)

Why a wire?

Let's sub in stress and strain formulas into formula for Young Modulus. We get that:

$$E = \frac{\frac{F}{A}}{\frac{x}{L}}$$

$$\frac{xE}{L} = \frac{F}{A}$$
$$x = \frac{FL}{EA}$$

The Young Modulus E is just a number for copper. We cannot make the force F (weight of mass) too big as that would require huge weights. We can change A (cross sectional area) and L length of material. We want to maximise x (the extension) because this is what we measure and this is maximised by minimising A and maximising L which is a wire.

How to work out Young Modulus

Making F the subject of the formula from the equation in the Why a wire? section we get

$$F = x\left(\frac{EA}{L}\right)$$

And so if we plot force F against extension x our gradient will be EA/L. We have measurements for A and L so we can work out E.

Equipment

- Copper wire
- 2 wooden blocks and a clamp
- Bench pulley
- Mass hanger and slotted masses up to 600g
- Metre ruler
- Micrometer screw gauge
- Sticky label
- Set square

Safety

1. Wire is under tension so must wear goggle in case the wire snaps
2. Take care while adding and removing masses (they may drop)

PS

Make sure to convert all the units to meters from millimeters and kilograms from grams.