Mok Man Hin 7B (19)

D2 Measurement of Young modulus of iron

Objective

To find out the Young modulus of iron by adding water into the water bucker to increase the load of the iron wire held. Record the extension of the wire at difference mass of load and plot out a graph of the extension of the iron wire against the mass of the load to find out the Young modulus of the iron wire.

Procedure

1. Measure the diameter of an iron wire at three different points along its length by a micrometer screw gauge. Take the mean value. Calculate its cross-sectional area (A).

	Data 1	Data 2	Data 3	Mean
Diameter of iron wire / mm	1.15	1.17	1.16	1.16

Cross-sectional area (A) = 1.0568×10^{-6} m^2

3. Measure the distance between the wooden blocks and the sticker, i.e. the unstretched original length (ℓ) of the copper wire.

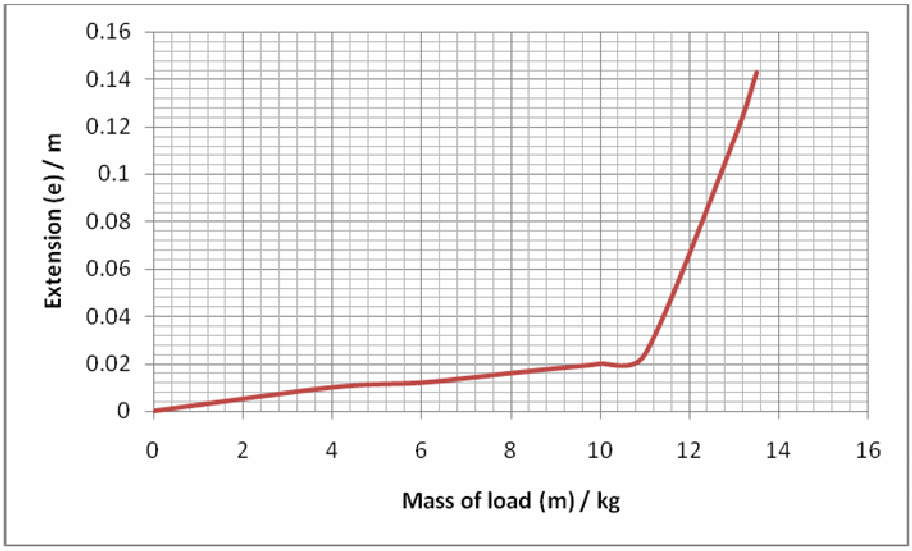
Unstretched original length (ℓ) = 2.42m

4. Add 500c.c. of water as load (m) to the water bucker holding with iron wire. Measure the extension of the iron wire (e) from the ruler.

5. Repeat step 4 until the iron wire breaks. Tabulate the results.

Mass of load (m) / kg	0	4	6	8	9	10	11	13	13.5
Extension (e) / m	0	0.01	0.012	0.016	0.018	0.02	0.024	0.115	0.143

6. Plot a graph of the extension (e) of the iron wire against the mass of the load (m). Find the slope of the graph.



 © Manhattan Press 2005

Apparatus

Iron wire x1 (2.42m)	Camera x 1
Half- miler Ruler x1 (66.1g)	Large Water bucket x2 (869.1g)
Water	500 ml Beaker x1
Measuring tape x1	Hook x1
Safety goggles x1	Miler Ruler x1

Mass of water bucker and the ruler = 0.9352kg

Mass of load added each time = 500/1000 = 0.5 kg

Theory

When a force is applied to a body, it deforms. By Hooke's Law, within elastic limits, the extension or compression (e) of the object is directly proportional to the force applied (F)

Stress = Force (F) /Cross-section area (A) and

Strain = Extension (e) / Original length (l)

Young modulus (E) = Stress / Strain = Fl / Ae

$= mgl/Ae$

Results and Discussion

1. Describe the shape of the graph of extension against load in step 6. Which part of the graph obeys Hooke's Law?

   At the beginning, the slope is nearly constant until 10 kg and then increase sharply from 10kg to 13.5kg until the wire breaks.

   From 0 kg to 10kg, the graph is obeying the Hooke's Law as the increase of mass of load is directly proportional to the increase of extension.

2. Calculate the Young modulus of iron by using Equation (1).

   $\sigma = F/A$

   $= mg/A$

   $= (13.5)(10) / 1.0568 \times 10^{-6}$

   $= 1.2774 \times 10^{8}$ Pa

 © Manhattan Press 2005

ε = e/l=0.143 /2.42

=0.059

$Y = \sigma / \varepsilon$

$= 2.16 \times 10^{9}$ Pa

3. Determine the elastic limit (the maximum load for elastic deformation) from the graph.

From the graph above, the wire extend significantly at 10 kg where is the elastic limit.

Elastic limit = 10 x10 /1.0568 x 10^{-6}

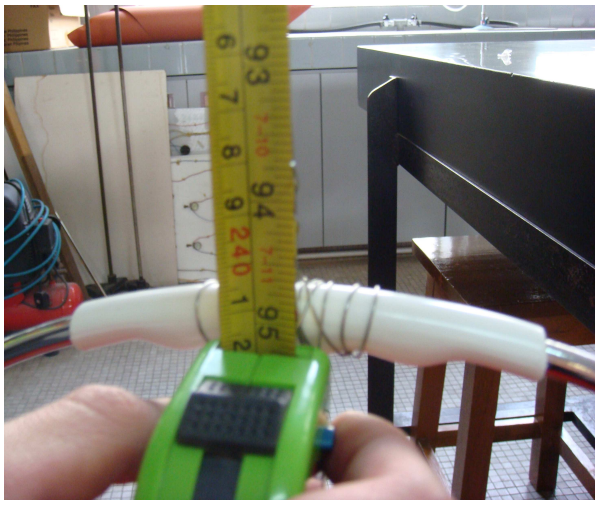
$= 9.462243941 \times 10^{7}$ Pa

Elastic limit = (10 + 0.9352) x10 /cross-section area

= 1.0347 x 108 Pa

4. State the sources of error and suggest improvements for this experiment.

- Reference wire should be used to compensate for the temperature variation during the experiment.
- Change in length might not be accurate after adding each mass as the wire might continue to extend therefore we should wait for a short time to ensure that the wire does not continue to extend.
- Sufficient mass should be used to remove any kinks and to make the wire taut.
- The ruler used to measure the extension should be fixed perpendicular to a massive object.



- Use a measuring tape to measure the length of the wire after holding it with a water

 © Manhattan Press 2005

bucker with a ruler.

- The ruler fixed on the water bucker should be placed on the middle of the water bucker for balance.
- The ruler fixed on the water bucker is used to prevent the tremble of the water bucker for easier observation.
- The water bucker used as a cushion should be same as the one held by the wire and should contain a sufficient amount of water in order to prevent the water splashing out and add mass to the bottom water bucket.
- Use the data in the pre-lab to find out the appropriate length for the wire to reduce the distance for the water bucker to travel.
- Due to the water will splash out and the crash may make the water bucker cleaves, safety goggles should be used to protect us.

5. Give a conclusion to this experiment.

   The iron wire obeys the Hooke's Law from 0 kg to 10 kg with elastic limit at 9.462243941×10^7 Pa. The young modulus of this iron wire is approximately at 2.16×10^9 Pa. The result is not accurate due to the amount of water added is not constant and the reading of extension is not correct due to the reading error.

 © Manhattan Press 2005