Unit 8 · Elasticity

HARDER PRACTICE QUESTIONS

Full marks 25

Write your answers on separate paper. Show your working. Take $g = 9.8\ m/s^2$. Young's modulus: steel $2.0 \times 10^{11}\ N/m^2$, copper $1.2 \times 10^{11}\ N/m^2$, bone $1.7 \times 10^{10}\ N/m^2$.

1 Spot the error [3]

Find the mistake and correct it.

A steel wire 2 m long, of cross-sectional area 1 mm^2, carries a load of 50 N. Pratik writes: "$A = 1\ mm^2 = 1 \times 10^{-3}\ m^2$, so $x = FL/(AY) = 50 \times 2 \div (10^{-3} \times 2 \times 10^{11}) = \mathbf{5 \times 10^{-7}\ m}$."

2 Predict, then explain [3]

Write your prediction first, then explain it.

A steel wire and a copper wire of the same length and diameter hang side by side, each with the same load.

i. Predict which stretches more.
ii. Find the ratio of their extensions.
iii. Which stores more elastic energy?

3 Read the data [5]

Answer from the table.

Rojina tests a wire 2.0 m long, of cross-sectional area $1.96 \times 10^{-7}\ m^2$, in Searle's apparatus:

Load (kg)	1	2	3	4	5
Extension (mm)	0.50	1.00	1.49	2.01	2.80

i. Which reading doesn't fit the pattern? What has probably happened?
ii. Using the other readings, find the extension per kilogram and the Young's modulus of the wire.
iii. Which metal could it be?
iv. When she takes the 5 kg off, will the wire go back to its original length? Explain.

4 Show that [3]

i. Show that a wire of length L, cross-sectional area A and Young's modulus Y behaves like a spring of force constant $k = YA/L$.
ii. A long wire is cut into two equal halves. What happens to the force constant of each half? Why?

5 Estimate it [3]

The numbers are rounded.

Suppose your thighbone is 45 cm long and its hard bone has a cross-sectional area of about 6 cm^2. Standing on both legs, each carries about 300 N. Estimate how much each thighbone is squeezed shorter. Would you notice it?

6 Correct the misconceptions [3]

The paragraph has three mistakes. Write each mistake and correct it.

> Kabita wrote: “Rubber is more elastic than steel, because it stretches so much more. Stress and pressure have the same unit, so stress is just another name for pressure. And the moment a wire passes its elastic limit, it breaks.”

7 Think [3]

Car tyres get warm on a long drive, even on a cool day. Using elastic hysteresis, explain why. Why would a tyre made of rubber with a smaller hysteresis loop save fuel?

8 Make your own [2]

Design a steel wire that stretches by exactly 1 mm under a load of 100 N. Choose its length and cross-sectional area, and show that it works.