

NOTE: for springs that obey Hooke's law:

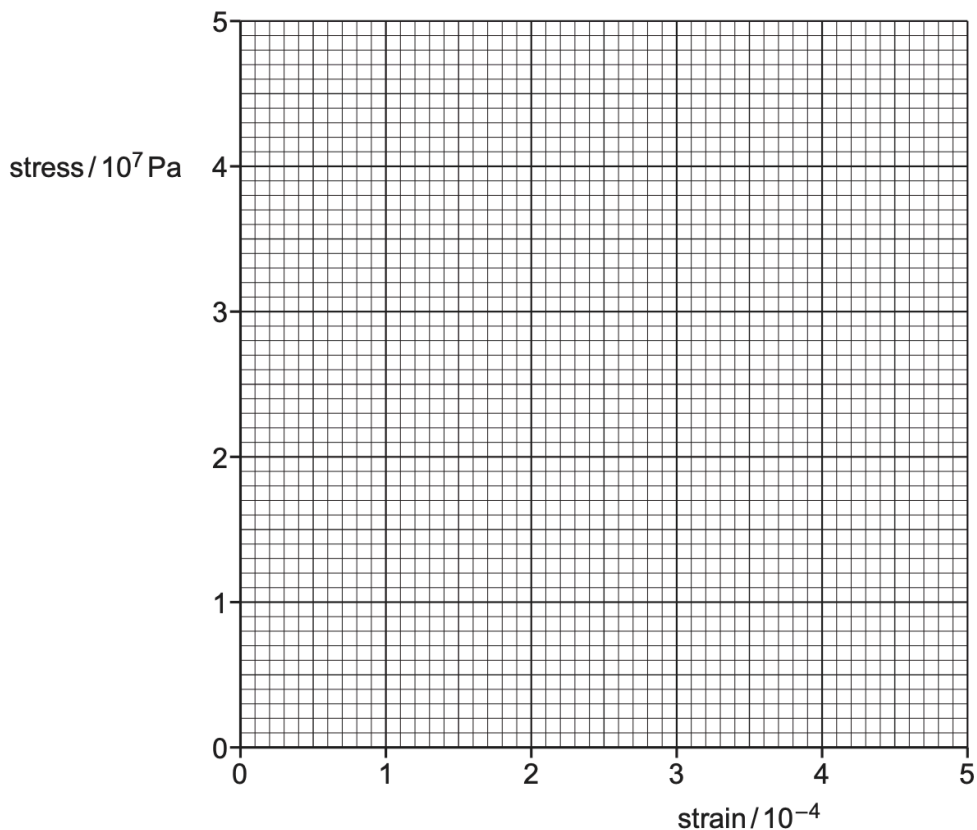
$$E = \frac{1}{2}Fx$$

1. Define strain
  - Extension / original length
2. State Hooke's law
  - Extension is proportional to applied force
- 3.

A copper wire of length 4.0m has a uniform cross-sectional area of  $4.5 \times 10^{-7} \text{ m}^2$ .

A tensile force of 18N is applied to the wire. This causes the wire to extend by 1.4mm up to its limit of proportionality.

- (ii) On Fig. 4.1, draw a line to show how the stress varies with the strain for the wire up to its limit of proportionality.



- straight line through the origin
- ending at the point (3.5, 4.0)
  - At limit of proportionality, extension = 1.4mm.  
Thus strain =  $(1.4 \times 10^{-3}) / 4 = 3.5 \times 10^{-4}$
  - Stress =  $18 / (4.5 \times 10^{-7}) = 4.5 \times 10^7$

- (c) A second copper wire has the same length as the wire in (b) but a larger diameter. Both wires are subjected to a tensile force of 18 N.

By placing a tick (✓) in each row, complete Table 4.1 to compare the stress and strain of the two wires.

**Table 4.1**

	greater in second wire	less in second wire	the same in both wires
stress			
strain			

[2]

	greater in second wire	less in second wire	the same in both wires
stress		✓	
strain		✓	

- If diameter increases, stress decreases
- If stress decreases, strain must also decrease to maintain the same Young's modulus, since it is the same material

4. Define the Young modulus of a material.

- Stress per unit strain

5. State the name of the quantity represented by the area under F–x curve.

- Elastic potential energy stored in the wire

6. A wire Q is made from a metal that has twice the Young modulus of the metal of wire P. Wire Q has the same volume as wire P but has double the cross-sectional area of wire P. The two wires are extended by equal tensile forces within their limits of proportionality. State and explain how the extension of wire Q compares with the extension of wire P.

length (of Q) is half (the length of P)

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extension is proportional to length, and inversely proportional to area and Young modulus

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extension of Q is  $= \frac{1}{2} / (2 \times 2)$

$= \frac{1}{8}$  times the extension of P

7.