

- 4 (a) A metal wire has spring constant  $k$ . Forces are applied to the ends of the wire to extend it within the limit of Hooke's law.  
Show that, for an extension  $x$ , the strain energy  $E$  stored in the wire is given by

$$E = \frac{1}{2}kx^2.$$

[4]

- (b) The wire in (a) is now extended beyond its elastic limit. The forces causing the extension are then removed.  
The variation with extension  $x$  of the tension  $F$  in the wire is shown in Fig. 4.1.

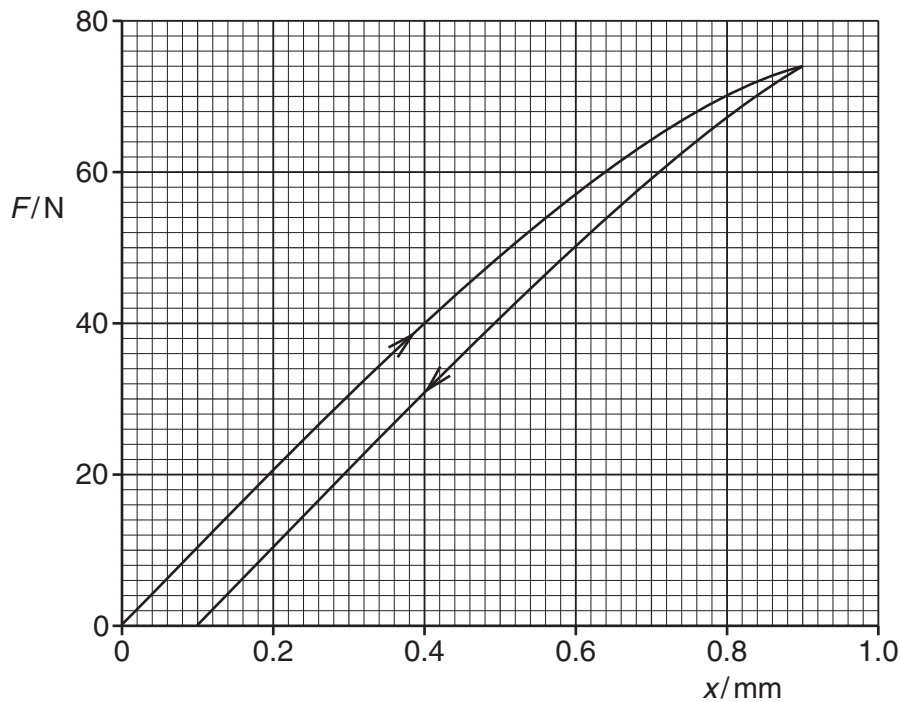


Fig. 4.1

Energy  $E_s$  is expended to cause a permanent extension of the wire.

- (i) On Fig. 4.1, shade the area that represents the energy  $E_s$ .

[1]

- (ii) Use Fig. 4.1 to calculate the energy  $E_S$ .

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$$E_S = \dots\dots\dots \text{mJ} [3]$$

- (iii) Suggest the change in the structure of the wire that is caused by the energy  $E_S$ .

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..... [1]