1 Fig 1.1 is used to investigate the variation of length *x* with tension of a light, uniform elastic band. The newton meters are calibrated prior to the experiment such that they do not have zero errors.

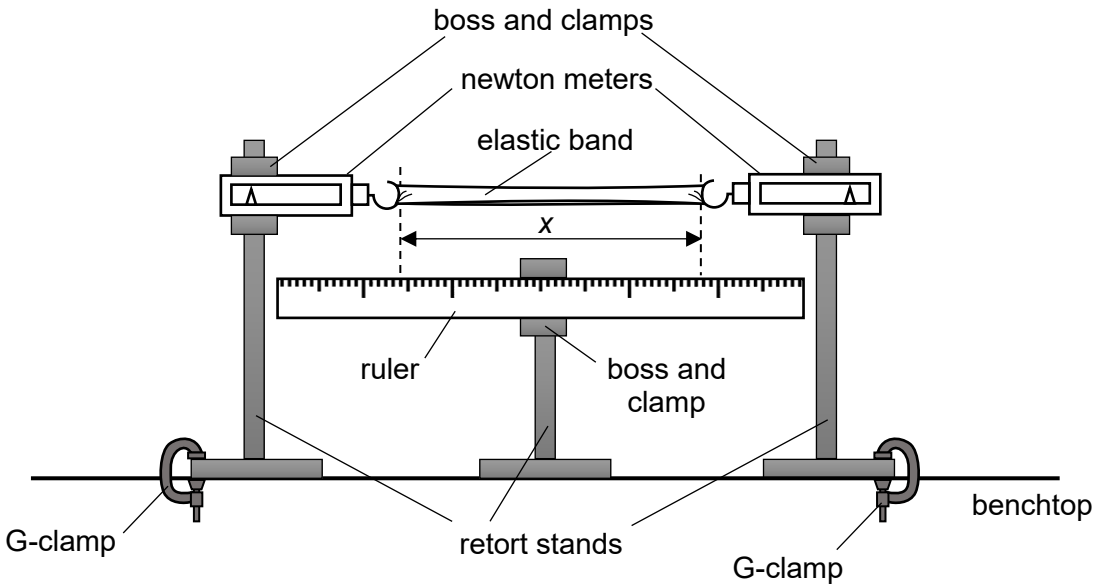

Fig. 1.1

(a) A measurement of the tension in the stretched elastic band is taken by averaging the readings across both newton meters.

State and explain if the magnitude of the readings on both newton meters should be identical. Hence, comment on the validity of the method.

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..... [2]

(b) An experiment is performed to determine the effective spring constant *k* of the elastic band. The measurements are shown in Fig. 1.2.

quantity	measurement	uncertainty
unstretched length, x_0	5.0 cm	± 0.3 cm
stretched length, x	17.5 cm	± 0.3 cm
tension, T	2.1 N	± 0.4 N

Fig. 1.2

(i) Calculate the effective spring constant k of the elastic band.

k = ... N m^{-1} [1]

(ii) Calculate the absolute uncertainty in the value of k.

absolute uncertainty = ... N m^{-1} [2]

(iii) Use your answer in **(b)(i)** and **(ii)** to state the value of k, with its absolute uncertainty, to an appropriate number of significant figures.

k = ... ± ..... N m^{-1} [1]

(c) A different experiment is performed using the same apparatus and set up as in Fig. 1.1. Each tension value has been plotted with vertical error bars representing its uncertainty on Fig. 1.3.

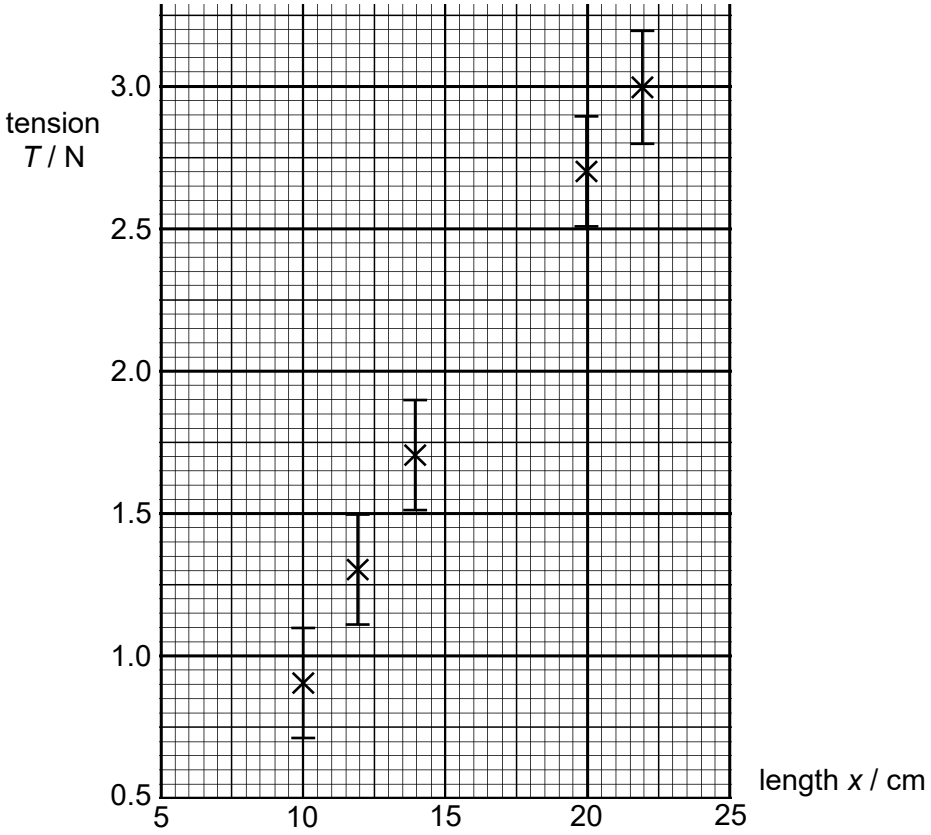

Fig. 1.3

(i) On Fig. 1.3, plot the data point with its uncertainty bars using the data in Fig. 1.2.[1]

(ii) Another method of finding the uncertainty of the spring constant Δk is through extreme fit lines. The greatest-possible and least-possible values of gradient are found, within the limits of uncertainty associated with each data point.

On Fig. 1.3, while ensuring that the fitted line lies entirely within the range of uncertainty of each data point,

1. plot the steepest-possible straight line through the data points.
2. plot the gentlest-possible straight line through the data points.

[1]

(iii) Hence, determine the uncertainty Δk, where

$$\Delta k = \frac{1}{2}\left(k_{\text{max}} - k_{\text{min}}\right)$$

Δk = ... N m^{-1} [1]

(d) Fig. 1.4 shows the variation of tension with length of the same elastic band measuring with a force sensor connected to a data logger. The dotted line shows the extrapolation of the data from **(c)** when they are fitted to a linear equation of the form of $y = mx + c$.

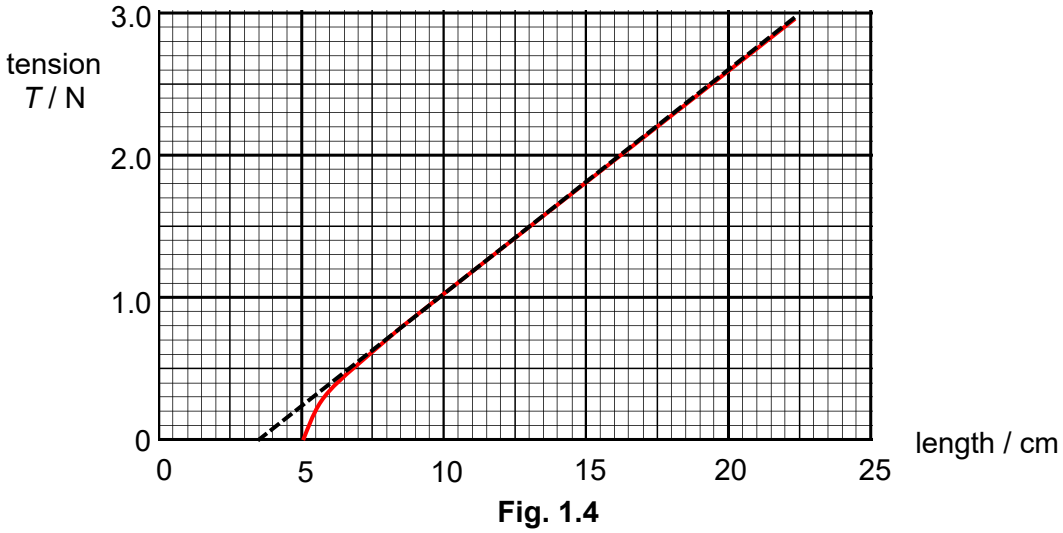

Fig. 1.4

Discuss the *accuracy* of the unstretched length of the elastic band obtained from the extrapolated data.

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..... [1]

[Total: 10]