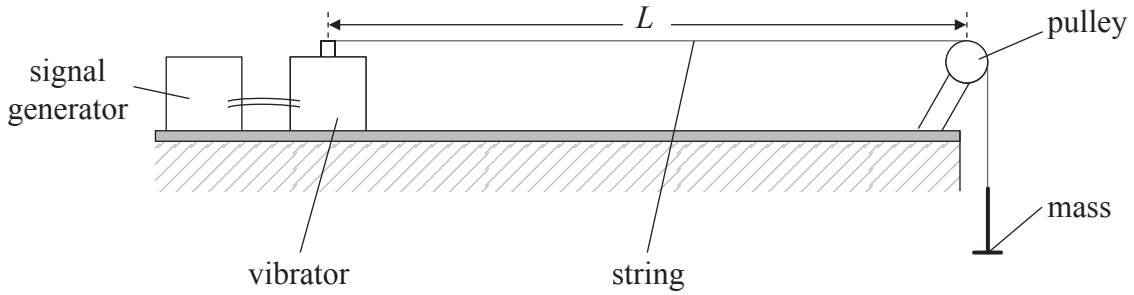
SECTION A

*Answer **all** the questions in the spaces provided.*

A1. Data analysis question.

The frequency f of the fundamental vibration of a standing wave of fixed length is measured for different values of the tension T in the string, using the apparatus shown.



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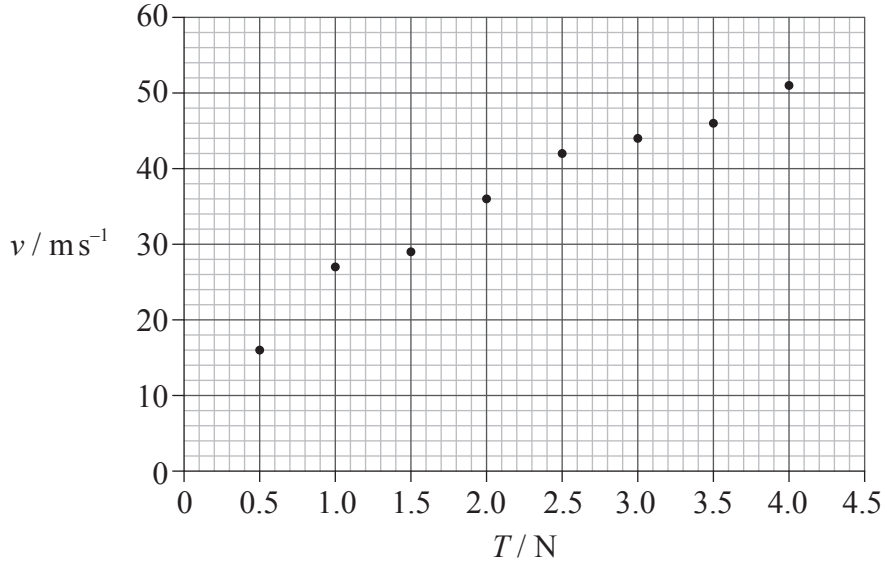
(Question A1 continued)

In order to find the relationship between the speed v of the wave and the tension T in the string, the speed v is calculated from the relation

$$v = 2fL$$

where L is the length of the string.

The data points are shown plotted on the axes below. The uncertainty in v is $\pm 5\,\text{m s}^{-1}$ and the uncertainty in T is negligible.



(a) Draw error bars on the first and last data points to show the uncertainty in speed v. *[1]*

(b) The original hypothesis is that the speed is directly proportional to the tension T. Explain why the data do **not** support this hypothesis. *[2]*

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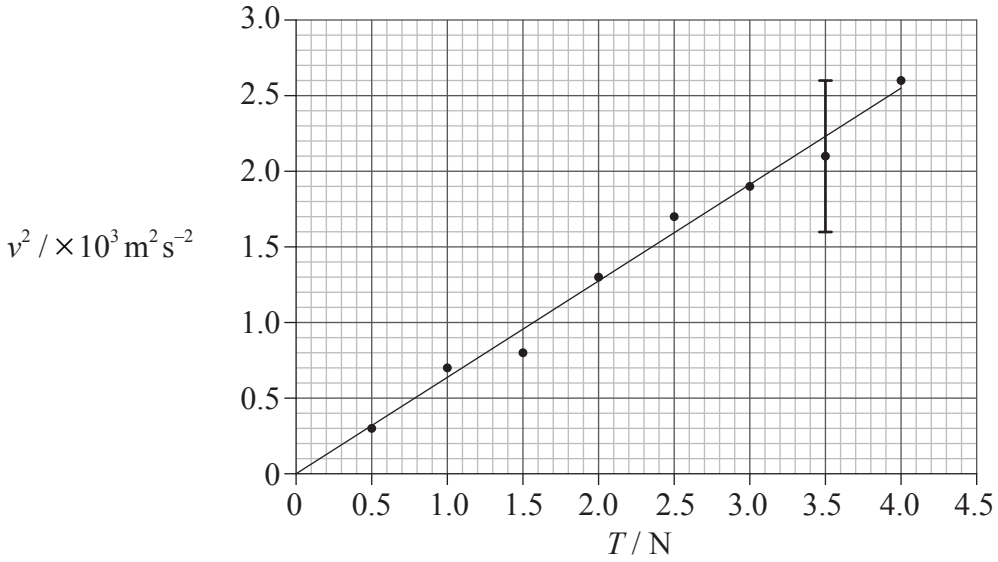
(Question A1 continued)

(c) It is suggested that the relationship between speed and tension is of the form

$$v = k\sqrt{T}$$

where k is a constant.

To test whether the data support this relationship, a graph of v^2 against T is plotted as shown below.



The best-fit line shown takes into account the uncertainties for each data point. The uncertainty in v^2 for $T = 3.5\,\text{N}$ is shown as an error bar on the graph.

(i) State the value of the uncertainty in v^2 for $T = 3.5\,\text{N}$. *[1]*

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(ii) At $T = 1.0\,\text{N}$ the speed $v = 27 \pm 5\,\text{m}\,\text{s}^{-1}$. Calculate the uncertainty in v^2. *[3]*

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(Question A1 continued)

(d) Use the graph in (c) to determine k without its uncertainty. *[4]*

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