2 In this experiment, you will investigate the tension in a string.

(a) • Set up the apparatus as shown in Fig. 2.1.

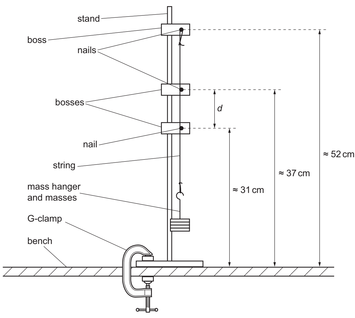

Fig. 2.1

• The mass hanger and masses should have a total mass M of 0.400 kg.

• The distance between the two lower nails is d, as shown in Fig. 2.1.

Measure and record d.

d = ... cm [1]

(b) The tension in the string is T.

Calculate T using $T = Mg$, where $g = 9.81\,\text{N kg}^{-1}$.

T = ... N [1]

(c) **(i)** • Hook the newton meter on the string half-way between the two lower nails and pull it horizontally with a force F of 5.0 N, as shown in Fig. 2.2.

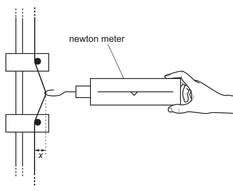

Fig. 2.2

• The force F causes the string to deflect a distance x, as shown in Fig. 2.2.

Measure and record x.

x = ... cm [2]

(ii) Estimate the percentage uncertainty in your value of x. Show your working.

percentage uncertainty = ...% [1]

(iii) Calculate y, where

$$y = \sqrt{\left(x^2 + \frac{d^2}{4}\right)}.$$

y = ... cm [1]

(d) • Add slotted masses to the mass hanger so that the total mass M is 0.700 kg.

• Repeat **(b)**, **(c)(i)** and **(c)(iii)**.

T = ... N

x = ... cm

y = ... cm
[3]

(e) It is suggested that the relationship between y, T and x is

$$ky = Tx$$

where k is a constant.

(i) Using your data, calculate **two** values of k.

first value of k = ...

second value of k = ...
[1]

(ii) Justify the number of significant figures that you have given for your values of k.

.....

.....

..... [1]

(f) It is suggested that the percentage uncertainty in the values of k is 20%.

Using this uncertainty, explain whether your results support the relationship in **(e)**.

.....

.....

.....

..... [1]

(g) **(i)** Describe **four** sources of uncertainty or limitations of the procedure for this experiment.

For any uncertainties in measurement that you describe, you should state the quantity being measured and a reason for the uncertainty.

1 .....

.....

2 .....

.....

3 .....

.....

4 .....

.....
[4]

(ii) Describe **four** improvements that could be made to this experiment. You may suggest the use of other apparatus or different procedures.

1 .....

.....

2 .....

.....

3 .....

.....

4 .....

.....
[4]

[Total: 20]