1 In this experiment, you will investigate the oscillation of masses on springs.

You have been provided with masses and springs.

Set up the apparatus as shown in Fig. 1.1.

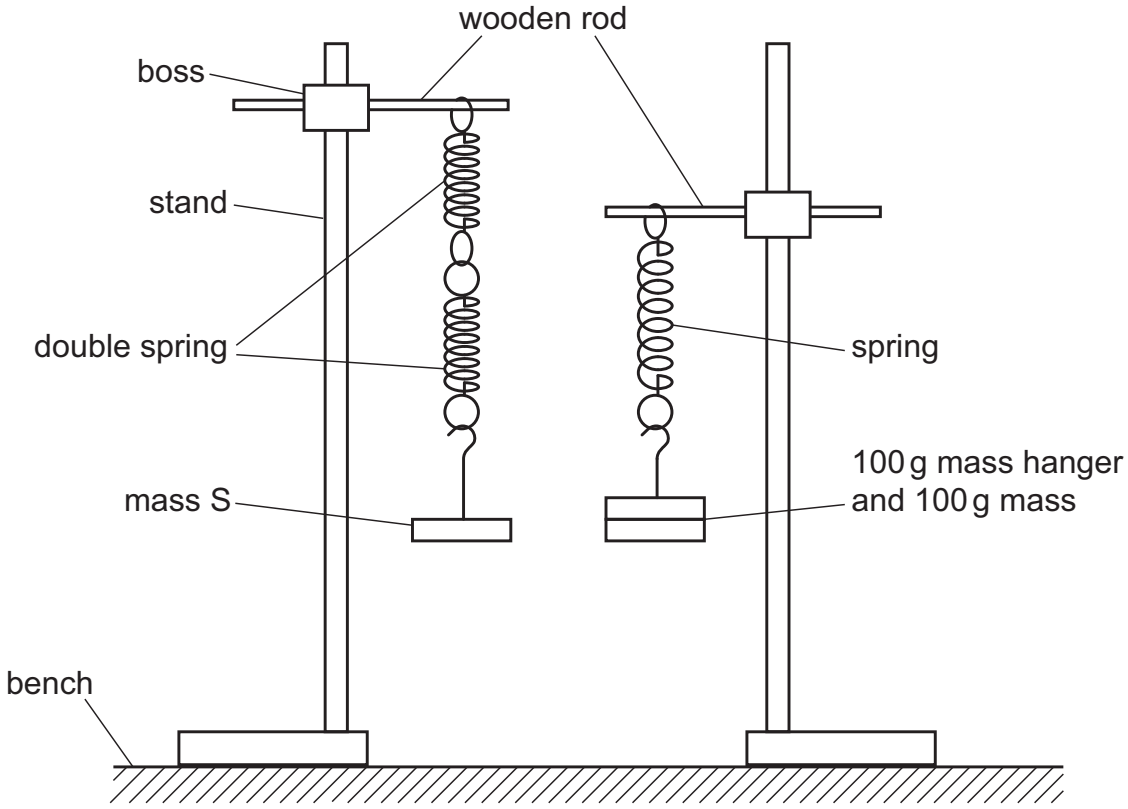

Fig. 1.1

(a)

- Ensure the bottoms of both masses are at the same level.
- Pull both masses down through a short distance and release them at the same time.
- Watch the oscillations of the masses. The masses initially oscillate in phase, then out of phase and then back in phase.
- The number of oscillations of mass S from release until the masses are back in phase for the first time is n_0.

  Determine and record n_0.

n_0 = ... [2]

(b) (i)

- Add a mass of 30 g to mass S. The added mass is M.
- Record M.

M = ...

- Repeat **(a)**. The number of oscillations of mass S from release until the masses are back in phase for the first time is n.
- Determine and record n.

n = ...
[1]

(ii) Calculate N, where

$$N = n_0 - n.$$

N = ... [1]

(c) Vary M by changing the number of 10 g masses added to mass S and determine n. Do **not** use $M = 0$.

Repeat until you have five sets of values of M and n.

Record your results in a table. Include values of N. Also include values of N^3 to three significant figures.

[8]

(d) **(i)** Plot a graph of N^3 on the y-axis against M on the x-axis. [3]

(ii) Draw the straight line of best fit. [1]

(iii) Determine the gradient and y-intercept of this line.

gradient = ...

y-intercept = ...

[2]

(e) It is suggested that the quantities N and M are related by the equation

$$N^3 = PM + Q$$

where P and Q are constants.

Using your answers in **(d)(iii)**, determine the values of P and Q.
Give appropriate units.

P = ...

Q = ...
[2]

[Total: 20]

You may not need to use all of the materials provided.

2 In this experiment, you will investigate the elastic properties of rubber cord.

(a) (i) You are provided with a wire with a clip and two slotted masses attached, as shown in Fig. 2.1.

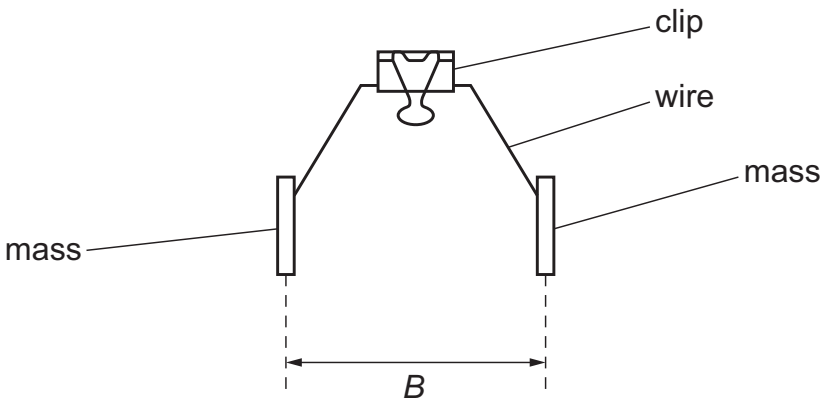

Fig. 2.1

The distance between the centres of the two slotted masses is *B*, as shown in Fig. 2.1.

Measure and record *B*.

B = ... [1]

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

percentage uncertainty = ...% [1]

(b) (i) • You are provided with two lengths of rubber cord. Select the **longer** cord.

• The diameter of the cord is *d*.

Measure and record *d*.

d = ... [1]

(ii) • Suspend the clip, wire and masses using the **longer** cord secured in the two clips, as shown in Fig. 2.2.

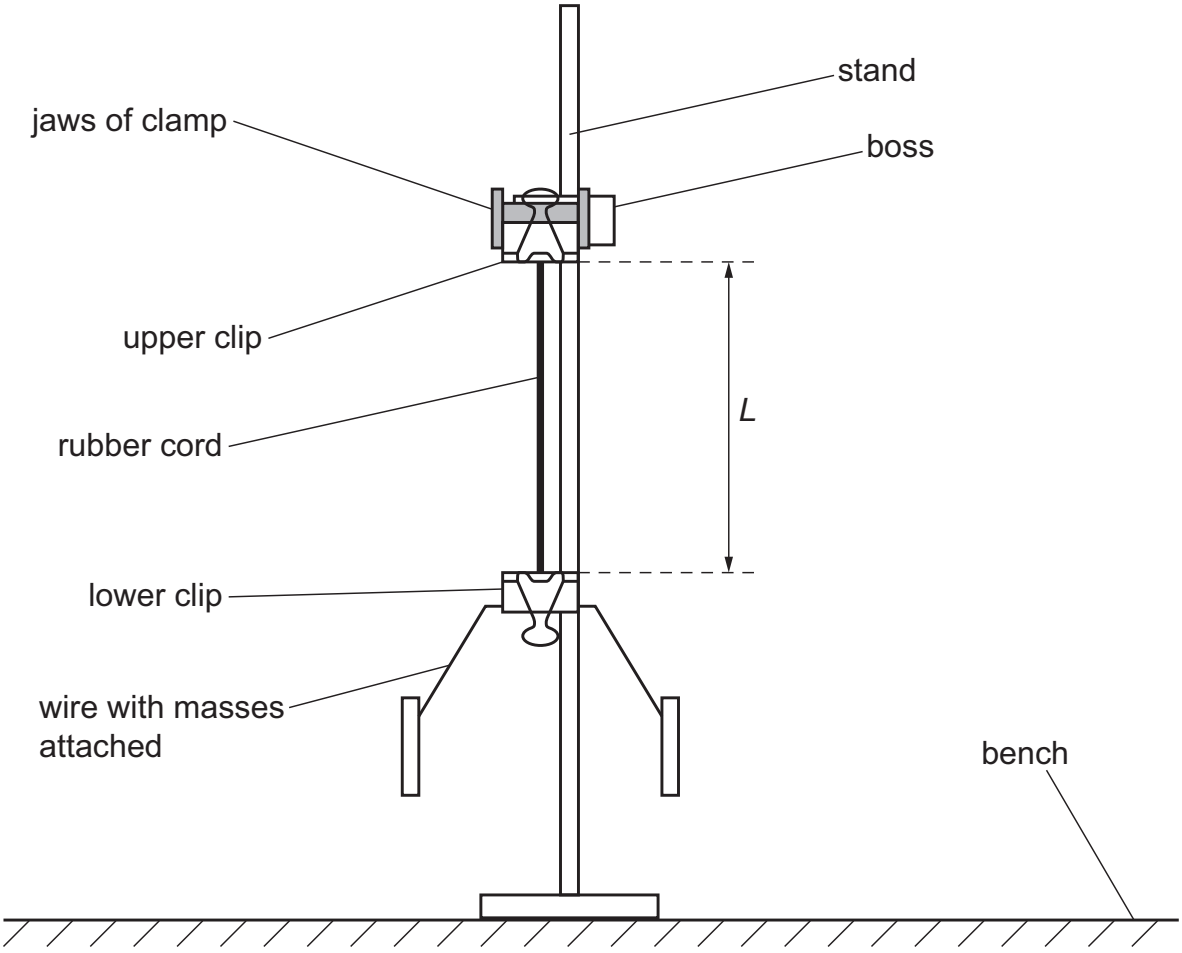

Fig. 2.2 (not to scale)

• The length of cord between the two clips is *L*, as shown in Fig. 2.2.

Measure and record *L*.

L = ... [1]

(iii) • Keeping the cord vertical, rotate the lower clip through approximately 180° and release the clip. The clip will rotate with a small number of oscillations.

• Take measurements to determine the period T of these oscillations.

T = ... s [2]

(c) Using the **shorter** length of rubber cord, repeat **(b)**.

d = ...

L = ...

T = ... s
[3]

(d) It is suggested that the relationship between T, B, L and d is

$$T^2 = \frac{B^2 L}{k d^4}$$

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]

(e) 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 **(d)**.

.....

.....

.....

..... [1]

(f) (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]