1 A student investigates the stretching of a spring.

Fig. 1.1 shows the set-up.

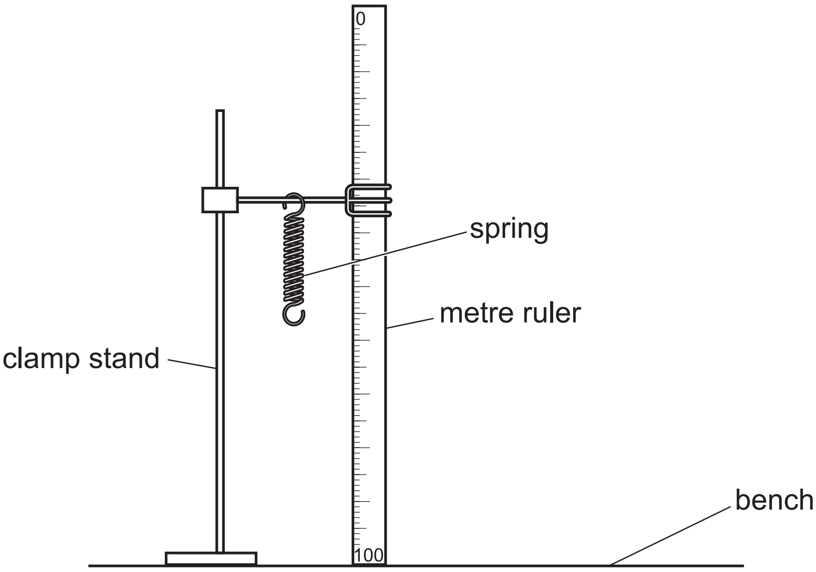


Fig. 1.1

(a) The student measures, and records in Table 1.1, the unstretched length l_0 of the spring. He does **not** include the loops at the ends of the spring in the measurement. The value l_0 is the length of the spring when the load L on the spring is 0.00 N.

Describe **one** technique you would use to obtain an accurate value for l_0. Draw a diagram to illustrate your answer.

....

....

.... [2]

(b) The student suspends a load L = 1.00 N from the spring. He records the new length l of the spring in Table 1.1.

He calculates the extension e of the spring using the equation $e = (l - l_0)$ and records the value of e in Table 1.1.

The student repeats the procedure using loads L = 2.00 N, 3.00 N, 4.00 N and 5.00 N.
The readings and results are recorded in Table 1.1.

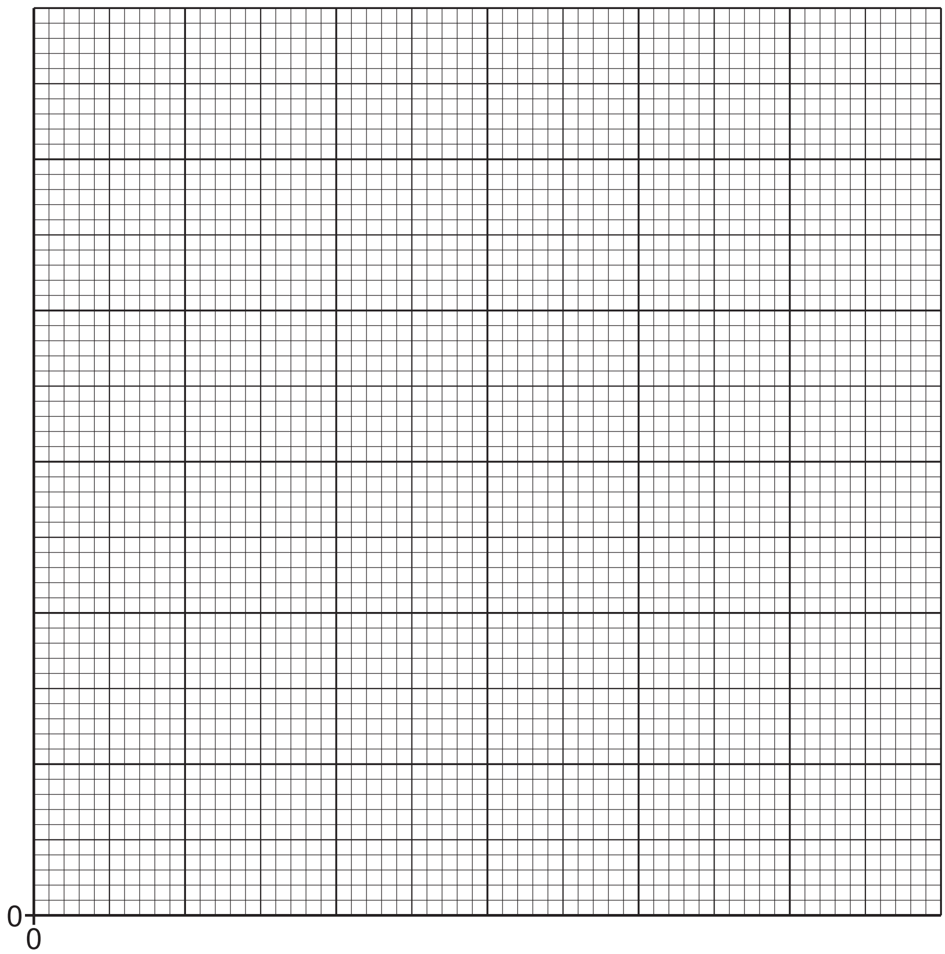
Calculate the extension e of the spring using the equation $e = (l - l_0)$ when L = 5.00 N. Record this value of e in Table 1.1.

Table 1.1

L / N	l / cm	e / cm
0.00	2.1	0.0
1.00	6.0	3.9
2.00	10.6	8.5
3.00	14.9	12.8
4.00	19.3	17.2
5.00	23.7	

[1]

(c) Plot a graph of L / N (y-axis) against e / cm (x-axis). Start both axes at the origin (0, 0). Draw the best-fit line.



[4]

(d) Determine the gradient *G* of the graph. Show all your working and indicate on the graph the values you use.

G = ... [2]

(e) *G* is numerically equal to the spring constant *k*.

Record the value of *k* to a suitable number of significant figures for this experiment. Include the unit.

k = ... [2]

[Total: 11]

1 A student measures the spring constant *k* of a spring by two different methods.

The spring constant *k* of a spring is a measure of how difficult the spring is to stretch.

Method 1

(a) The student:

- attaches the spring to a clamp, as shown in Fig. 1.1

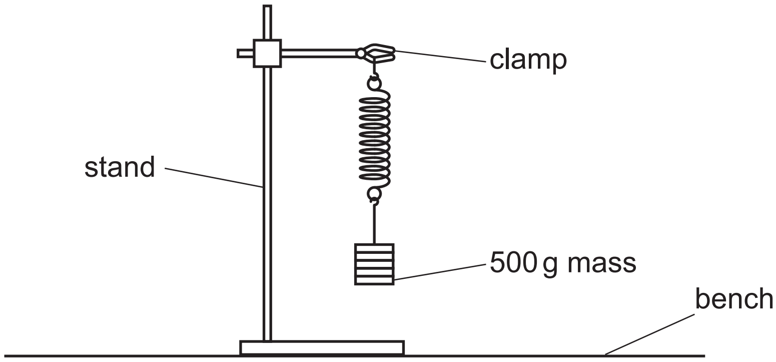


Fig. 1.1

- suspends a mass *m* = 500 g from the spring
- pulls the mass down a small distance and releases it.

The mass oscillates up and down.

(i) The student measures the time *t* taken for 20 oscillations of the mass.

The reading on the stop-watch is shown in Fig. 1.2.

Record *t* in Table 1.1.

Fig. 1.2

Table 1.1

m / g	*t* / s	*T* / s
500		

[1]

(ii) The period *T* of the oscillations is the time taken for **one** oscillation.

Calculate the period *T* of the oscillations.

Record your answer in Table 1.1. [1]

(b) Suggest how the procedure can be improved to increase the accuracy of the result.

....

.... [1]

(c) Calculate a value k_1 for the spring constant of the spring.

Use the equation shown.

$$k_1 = \frac{19.7}{T^2}$$

k_1 = ... N/m [1]

Method 2

(d) The student measures the stretched length *l* of the spring, with the 500 g mass still attached, in centimetres to the nearest 0.1 cm.
Fig. 1.3 shows the stretched spring drawn to a scale of one-quarter full size.

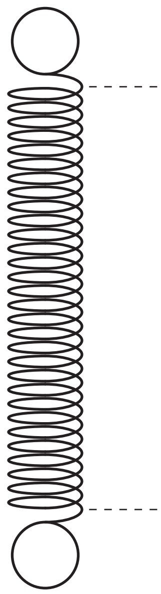


Fig. 1.3

(i) The length *L* of the spring is the distance between the dotted lines in Fig. 1.3.

Measure *L*.

L = ... cm [1]

(ii) Calculate the actual stretched length *l* of the spring.

l = ... cm

Record *l* in Table 1.2.

Table 1.2

m / g	*l* / cm
500	
400	18.3
300	14.3
200	10.0
100	6.1

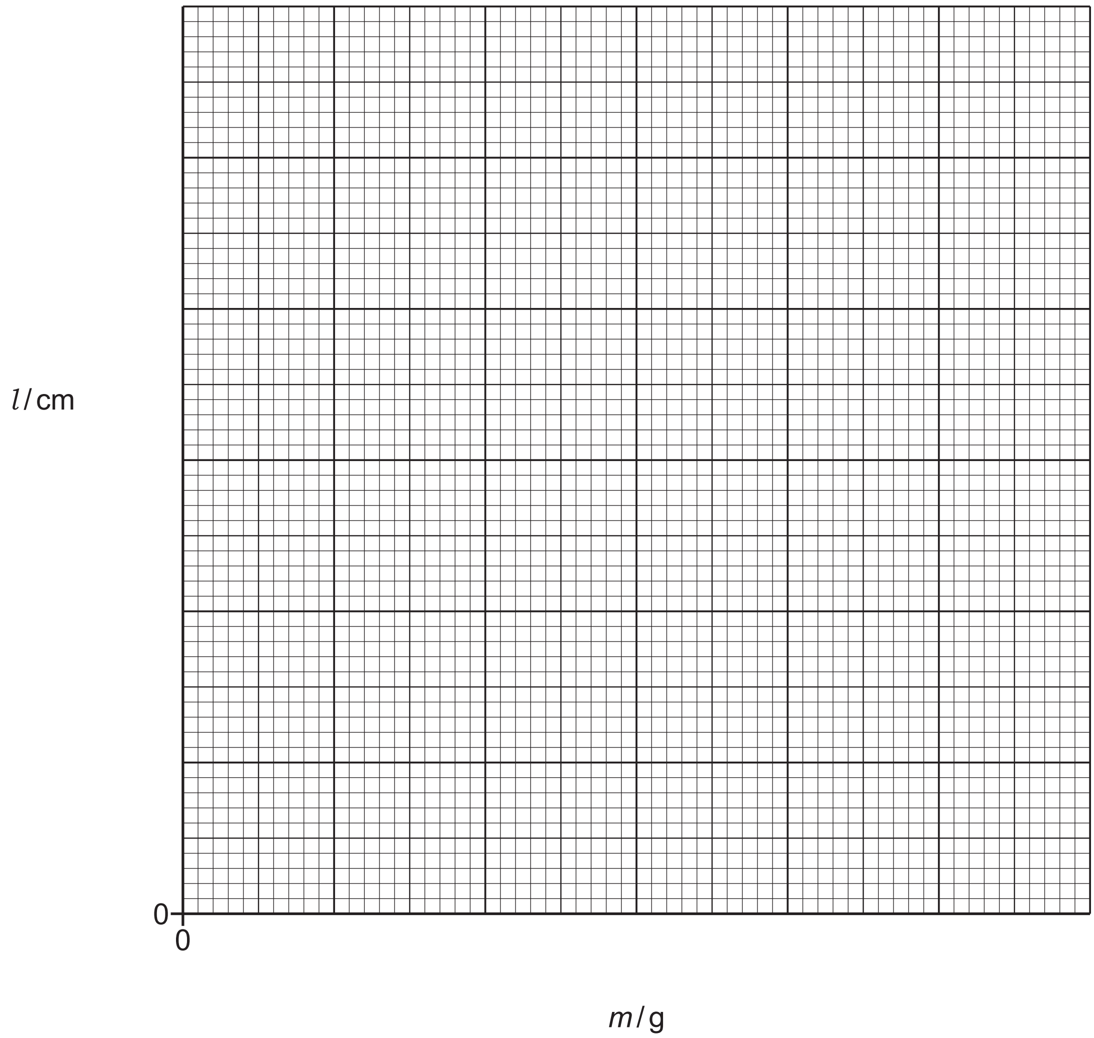
[1]

(e) The student removes the 100 g masses from the mass hanger, one at a time, and repeats the procedure for masses of *m* = 400 g, 300 g, 200 g and 100 g.

The student records each value of *l* in Table 1.2.

(i) Plot a graph of l / cm (y-axis) against m / g (x-axis). Start your axes at the origin (0, 0).

Draw the best-fit line.



[3]

(ii) Calculate the gradient G of your line. Show all your working and indicate on the graph the values you use.

G = ... [1]

(iii) An estimated value k_2 for the spring constant of the spring can be calculated using the equation

$$k_2 = \frac{1}{G}.$$

Calculate k_2 using your value of G from **(e)(ii)** and the equation shown.

k_2 = ... N / m [1]

(f) Two quantities can be considered to be equal within the limits of experimental accuracy if their values are within 10% of each other.

Compare your values of k_1 from **(c)** and k_2 from **(e)(iii)**.

State whether your results indicate that the values can be considered to be equal.

Support your statement with a calculation.

....

....

[2]

[Total: 13]

1 A student investigates the stretching of a spring.

Fig. 1.1 shows the set-up.

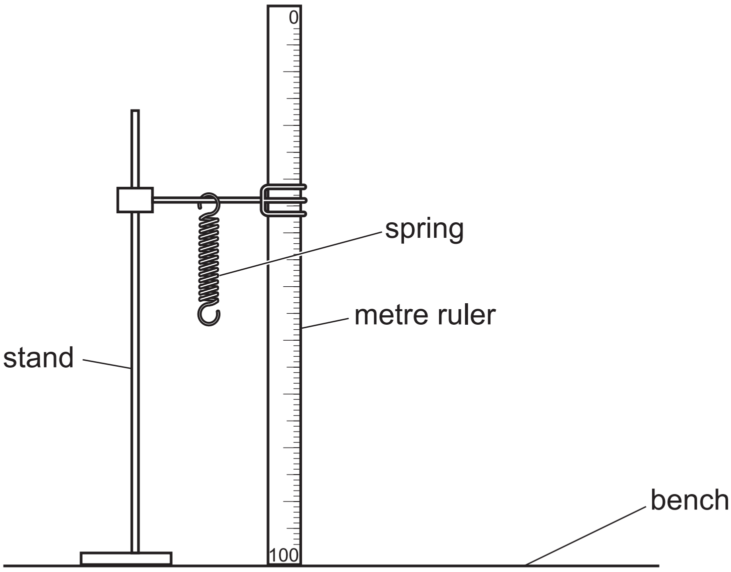


Fig. 1.1

(a) The value l_0 is the length of the spring when the load L is 0.0 N.

The student measures the length l_0 of the spring. She records l_0 = 16 mm in Table 1.1.

Draw a diagram of the spring to show clearly the length l_0 of the spring.

[1]

(b) The student suspends a load L = 0.20 N from the spring. She records the new length l of the spring in Table 1.1.

She repeats the procedure using loads L = 0.40 N, 0.60 N, 0.80 N and 1.00 N. The readings are shown in Table 1.1.

(i) Calculate the extension e of the spring for each load using the equation $e = (l - l_0)$.

Record the values of e in Table 1.1.

[2]

(ii) Complete the column headings in Table 1.1.

Table 1.1

L /	l /	e /
0.00	16	0
0.20	18	
0.40	21	
0.60	23	
0.80	24	
1.00	26	

[1]

(c) Plot a graph of L (y-axis) against e (x-axis).

Draw the best-fit line.

[4]

(d) Use the graph to determine e_A, the extension produced by a load of 0.50 N. Show clearly on the graph how you obtained the necessary information.

e_A = ... [3]

[Total: 11]

1 A student investigates the stretching of a spring.

The apparatus is shown in Fig. 1.1.

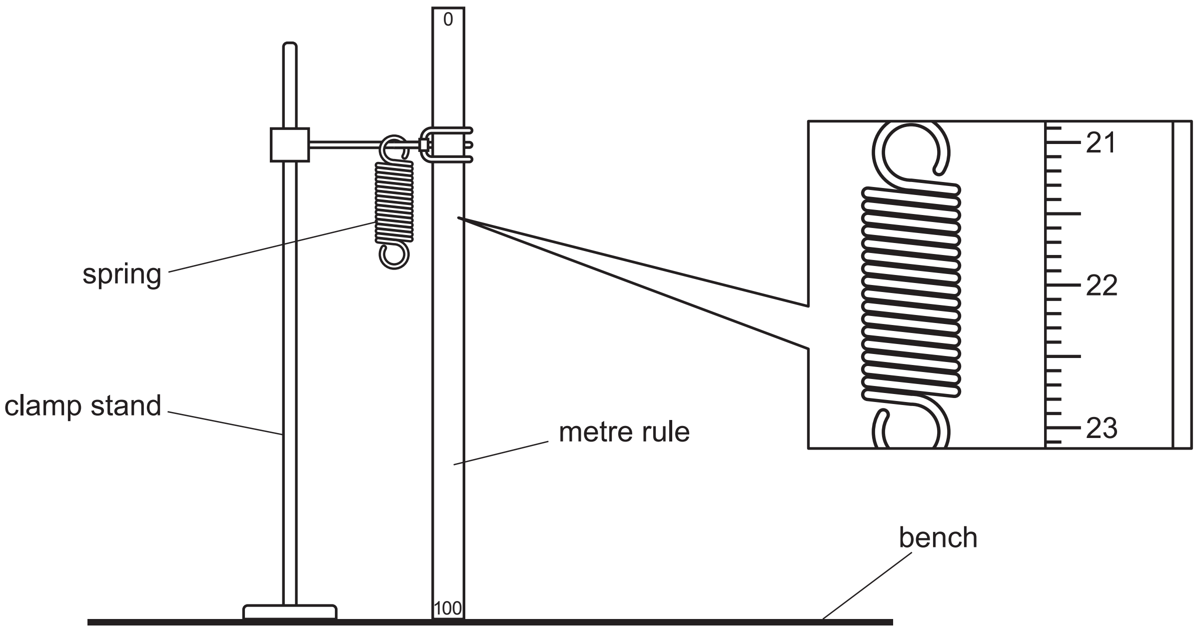


Fig. 1.1

(a) **(i)** On Fig. 1.1, take two readings from the metre rule to determine the unstretched length l_0 of the coiled part of the spring.

reading 1 .... cm

reading 2 .... cm

l_0 = ... cm
[3]

(ii) Draw a diagram to show clearly how you would use a set square to obtain an accurate reading from the metre rule.

[1]

(b) The student suspends a load of $P = 1.0\,N$ from the spring.

He records the new length l_1 of the coiled part of the spring.

l_1 = ...2.2.......................... cm

Calculate the extension e_1 using the equation $e_1 = (l_1 - l_0)$.

e_1 = ... cm

Calculate a value for the spring constant k of the spring using the equation

$$k = \frac{P}{e_1}.$$

Include the unit.

k = ...

[2]

(c) The student suspends a load of $P = 5.0\,N$ from the spring.

He records the new length l_5 of the coiled part of the spring.

l_5 = ...6.3.......................... cm

Calculate the extension e_5 using the equation $e_5 = (l_5 - l_0)$.

e_5 = ... cm

Calculate a second value for the spring constant k of the spring using the equation

$$k = \frac{P}{e_5}.$$

Give your answer to two significant figures.

k = ...

[2]

(d) State whether your two values of the spring constant *k* can be considered equal within the limits of experimental accuracy.

Explain your answer by referring to your results.

statement ....

explanation ....

....

.... [1]

(e) A student improves the experiment by taking additional sets of readings.

(i) Suggest the additional apparatus that the student uses.

....

.... [1]

(ii) Suggest how the student uses the additional results.

....

.... [1]

[Total: 11]

1 A student investigates the extension of a spring and uses it to determine the weight of a metre rule.

The spring is shown full size in Fig. 1.1 and Fig. 1.2.

Fig. 1.1 shows the spring without any load.
Fig. 1.2 shows the spring with a load of 1.0 N suspended from it.

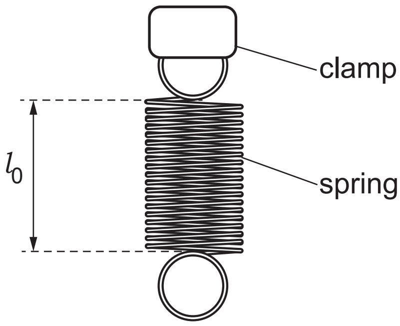


Fig. 1.1

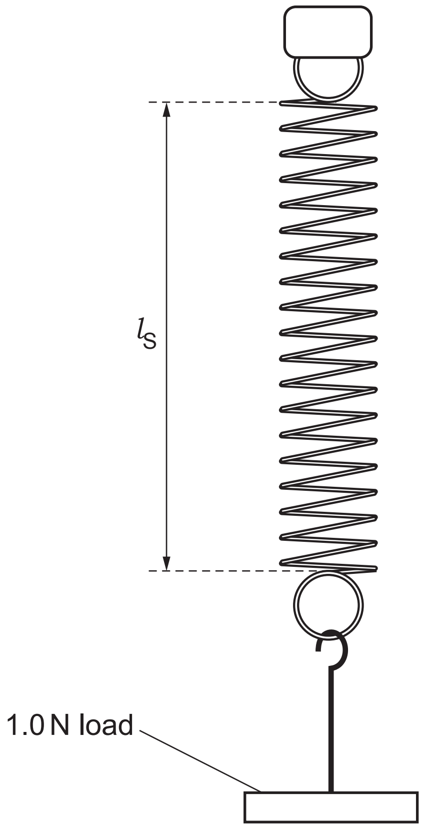


Fig. 1.2

(a) On Fig. 1.1, measure the length l_0 of the spring without any load.

l_0 = ... cm

On Fig. 1.2, measure the stretched length l_S of the spring.

l_S = ... cm
[2]

(b) The student attaches a metre rule to the spring with a wire hook, as shown in Fig. 1.3. The scale of the metre rule faces upwards.

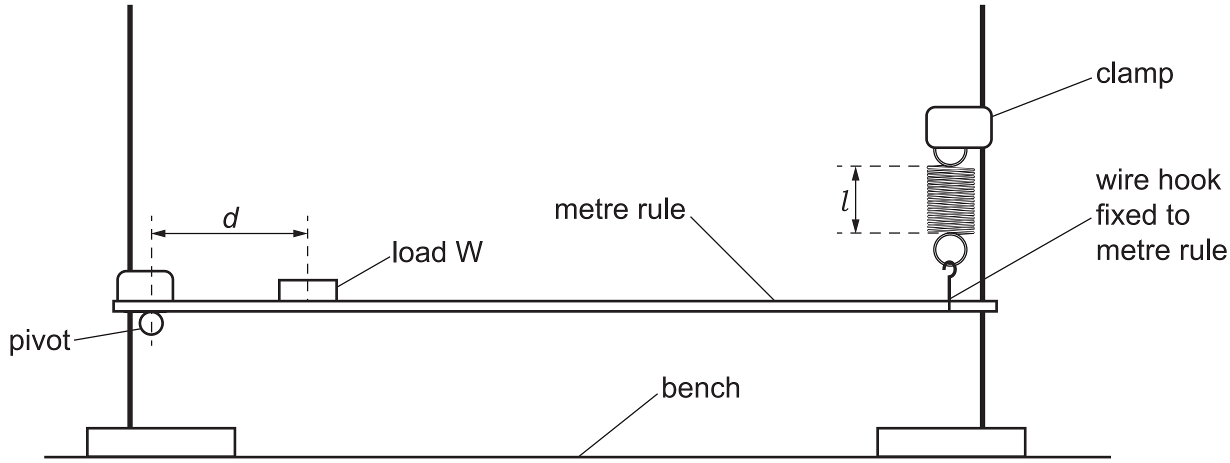


Fig. 1.3

She ensures that the metre rule is horizontal.

Briefly describe how to check that the rule is horizontal. You may draw a diagram if it helps to explain your answer.

....

....

.... [1]

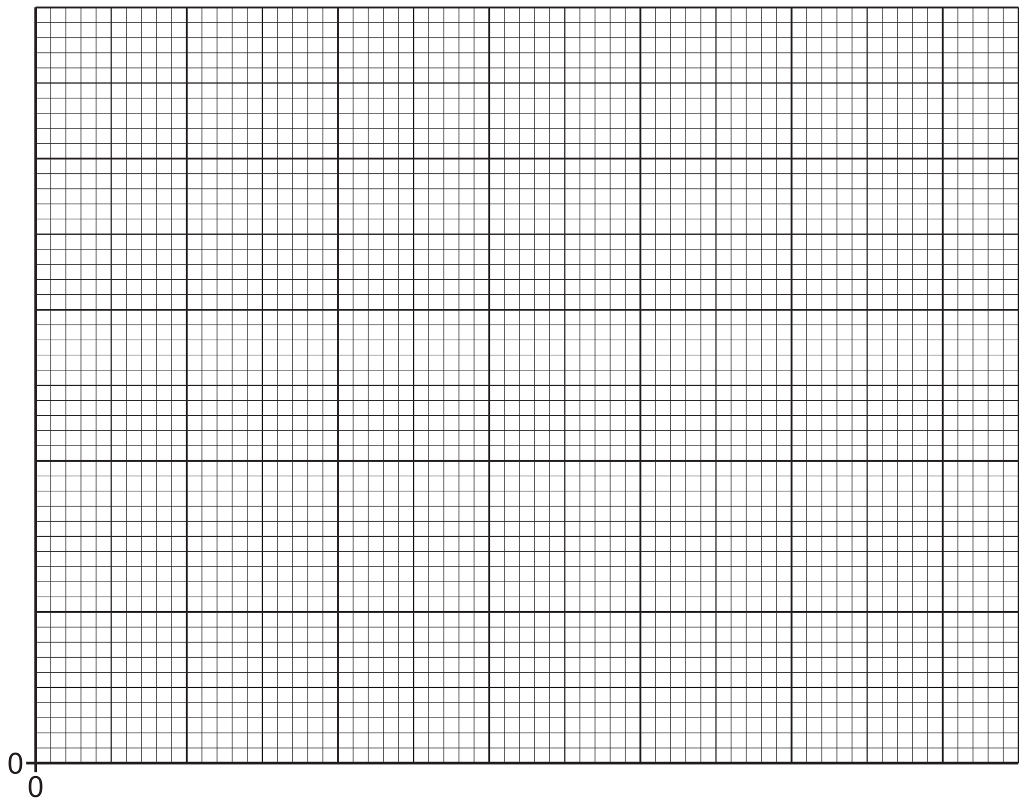
(c) The student moves load W to distances d = 20.0 cm, d = 30.0 cm, d = 40.0 cm, d = 50.0 cm and d = 60.0 cm from the pivot.

She reads the length l of the spring for each value of d.
Her readings are shown in Table 1.1.

Table 1.1

d / cm	l / cm
20.0	6.2
30.0	7.1
40.0	7.6
50.0	8.3
60.0	9.0

(i) Using the values from Table 1.1, plot a graph of l / cm (y-axis) against d / cm (x-axis). Start the axes at the origin (0,0).



[4]

(ii) From your graph, determine L, the value of l when d = 0.0 cm.

L = ... [1]

(iii) Calculate W_R, the weight of the metre rule, using your value of L from **(c)(ii)**, the values of l_0 and l_S from **(a)** and the equation

$$W_R = \frac{2(L - l_0)}{(l_S - l_0)} \times k$$

where k = 1.0 N.

W_R = ... [1]

(d) (i) It is sometimes difficult to position the load W on the scale of the metre rule at the correct distance d from the pivot.

Suggest **one** change to the apparatus to overcome this difficulty.

....

.... [1]

(ii) Suggest **one** possible source of inaccuracy other than the difficulty described in **(d)(i)**. Assume that the experiment is carried out carefully.

....

.... [1]

[Total: 11]

Question	Answer	Marks
1(a)	keep ruler close to spring **OR** use a set square (or pointer) **OR** view scale at right angles **OR** lay spring on bench **OR** use calipers	
	technique above described in words	**1**
	diagram including ruler to show a correct method - this may be shown on Fig. 1.1	**1**
1(b)	21.6	**1**
1(c)	graph: • axes correctly labelled and right way round	**1**
	• appropriate scales (plots occupying at least ½ grid between plotted points)	**1**
	• plots all correct to ½ small square <u>and</u> precise plots	**1**
	• well-judged line <u>and</u> thin line	**1**
1(d)	triangle method clearly shown on graph	**1**
	using at least half of distance between extreme plots	**1**
1(e)	$k = G$ and to 2 or 3 significant figures	**1**
	N / cm	**1**

Question	Answer	Marks
1(a)(i)	17.76 (s)	**1**
1(a)(ii)	T calculation correct from candidate's value, expect 0.888	**1**
1(b)	(time a) greater number of oscillations	**1**
1(c)	k_1 calculation correct, expect 25.0	**1**
1(d)(i)	5.6 (cm)	**1**
1(d)(ii)	22.4 (cm) / candidate's **(d)(i)** × 4	**1**
1(e)(i)	graph: • appropriate scales (plots occupying at least ½ grid between plotted points)	**1**
	• plots all correct to ½ small square <u>and</u> precise plots	**1**
	• well-judged line <u>and</u> thin line	**1**
1(e)(ii)	any indication <u>on the graph</u> as to how gradient found <u>and</u> correct <u>method</u> of calculation of gradient i.e., $\Delta y / \Delta x$ shown	**1**
1(e)(iii)	k_2 = 23.5 – 26.4 inclusive	**1**
1(f)	statement to match candidate's values of k_1 and k_2	**1**
	<u>values used</u> in a calculation to justify the statement	**1**

Question	Answer	Marks
2(a)	V = 0.84 (V)	**1**
	I = 0.36 (A)	**1**
2(b)	2.3(3......)	**1**
	2.3 (Ω)	**1**

Question	Answer	Marks
1(a)	diagram clearly showing the distance l_0 <u>marked</u>	**1**
1(b)(i)	second *e* value: 2	**1**
	remaining *e* values: 5, 7, 8, 10	**1**
1(b)(ii)	N, mm, mm cao	**1**
1(c)	graph: • axes correctly labelled with quantity and unit and the right way round	**1**
	• suitable scales filling ≥ ½ the grid between the extreme plotted points	**1**
	• six plots correct to ½ small square – origin must be included	**1**
	• good line judgement, thin, continuous line	**1**
1(d)	correct method shown clearly on graph	**1**
	candidate's value read correctly to ½ small square	**1**
	5.2 ± 0.2 (mm)	**1**

Question	Answer	Marks
1(a)(i)	21.3 (cm)	**1**
	22.8 (cm) (or the other way round)	**1**
	l_0 = 1.5 (cm)	**1**
1(a)(ii)	set square method clearly shown	**1**
1(b)	correct calculation of *k*; P divided by candidate's e_1 quoted to 2 or more significant figures	**1**
	N / cm	**1**
1(c)	e_5 = 4.8 (cm)	**1**
	k given to 2 significant figures	**1**
1(d)	statement to match results and explanation to match statement	**1**
1(e)(i)	additional load(s)	**1**
1(e)(ii)	plot a graph OR take an average	**1**

Question	Answer	Marks
1(a)	l_0 = 2(.0) (cm) and l_S = 6.2 (cm)	1
	both to 1 decimal place	1
1(b)	suitable method e.g. measure distance from bench at each end and check equal	1
1(c)(i)	graph: • axes labelled with quantity and unit	1
	• appropriate scales (occupying at least ½ grid)	1
	• plots all correct to ½ small square and precise plots	1
	• line well-judged and thin and extended to axis	1
1(c)(ii)	*L* read correctly from graph	1
1(c)(iii)	W_R in range 1.3 to 1.6 and with unit of N	1
1(d)(i)	suspend load from loop of thread / any other suitable method to avoid standing load over marks on rule	1
1(d)(ii)	valid source of uncertainty e.g. test load not exactly 1.0 N / spring extension not linear / metre rule not uniform	1