INVESTIGATING STRETCHING OF OBJECTS

1 A student has a selection of rubber bands of different widths. He is investigating the extension produced by adding loads. Fig. 4.1 shows the set-up used.

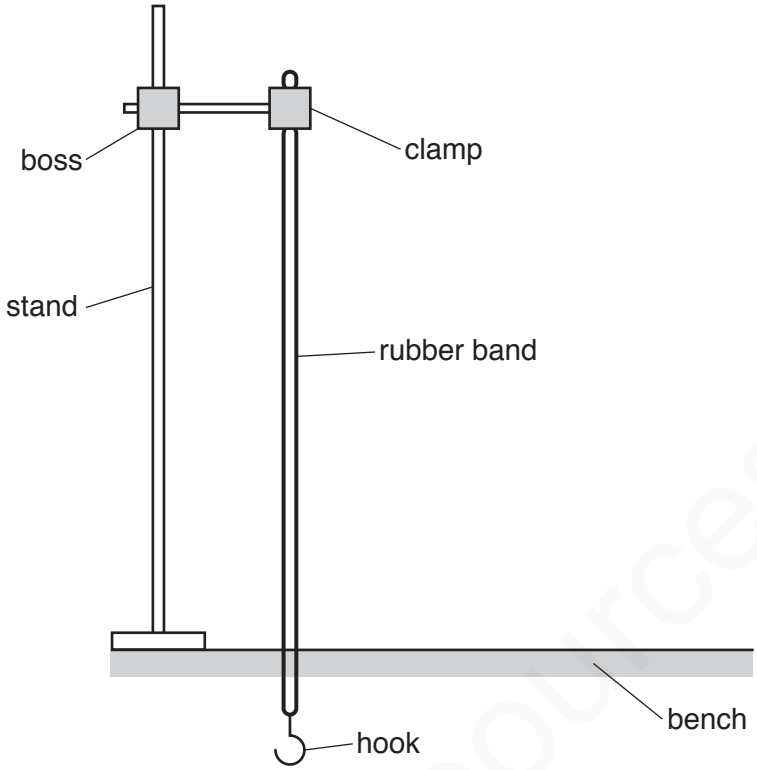

Fig. 4.1

In addition to the apparatus shown in Fig. 4.1, the following apparatus is available to the student:

A metre rule
A selection of different rubber bands
A selection of loads.

Plan an experiment to investigate how strips of rubber of different widths stretch when loaded.

You should

- explain briefly how you would carry out the investigation
- state the key variables that you would control
- draw a table, or tables, with column headings to show how you would display your readings (You are **not** required to enter any readings in the table.)
- explain briefly how you would use your readings to reach a conclusion.

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.....[7]

[Total: 7]

MARKING SCHEME

4	**method:** **MP1** measure length of band	**1**
	MP2 hang load, measure new length	**1**
	MP3 repeat with different thicknesses/widths	**1**
	control variable: **MP4** use same (original) length of band each time	**1**
	table: **MP5** table with columns for thickness, (load) and length / extension with units	**1**
	conclusion: **MP6** plot a graph of extension / length against thickness (for the same load) OR load against extension / length for different thicknesses OR comparison via a table e.g. compare extensions / lengths of different thicknesses for the same load	**1**
	one additional point: **MP7** use same load / same range of loads use at least 5 thicknesses / take at least 5 different readings to plot a graph show how to measure extension e.g. $l - l_0$ use same type / material of rubber band	**1**

2 A student is investigating the extension of a spring.

(a) Fig. 5.1 shows the spring with, and without, a load attached.

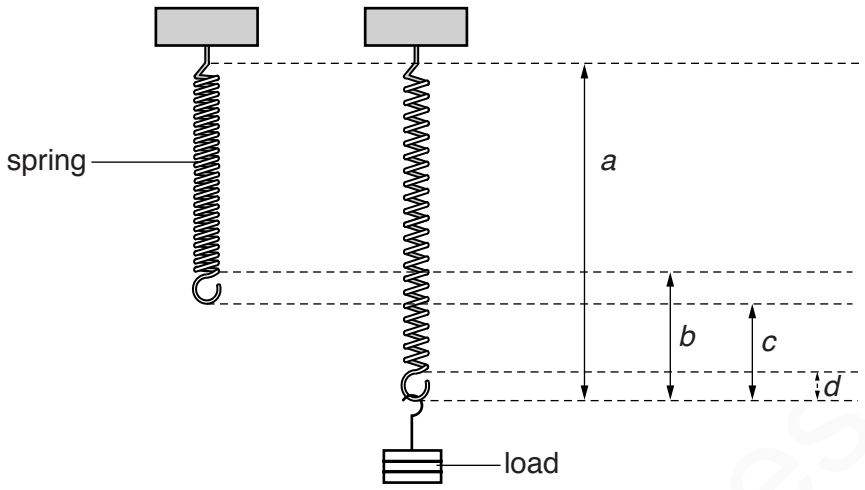


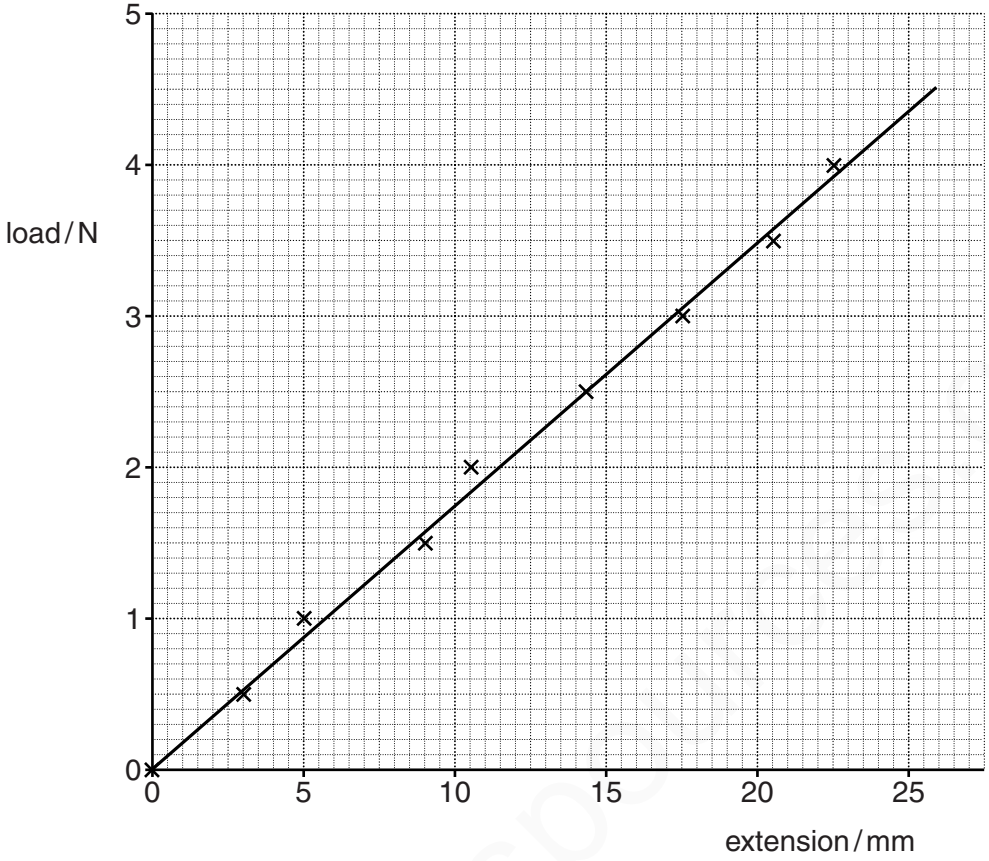
Fig. 5.1

Tick the distance that shows the extension of the spring when the load is added.

☐ *a* ☐ *b* ☐ *c* ☐ *d*

[1]

(b) The graph shows the student's results.



(i) State whether the graph shows that the load and the extension are directly proportional. Justify your answer by reference to the graph.

statement .....

justification .....

.....

[2]

(ii) The student determines the gradient *G* of the graph line.

G = ...0.1744729.....

G is numerically equal to a constant *k* for the spring.

Write down the value of the constant *k*. Give your answer to a suitable number of significant figures and include the unit.

k = ...[2]

[Total: 5]

MARKING SCHEME

5(a)	c	**1**
5(b)(i)	(yes) straight line through the origin	**1** **1**
5(b)(ii)	0.174 or 0.17 N/mm	**1** **1**
	Total:	**5**

3 The class is investigating the behaviour of a spring, and then using the spring to determine the weight of an object.

The apparatus is shown in Fig. 3.1.

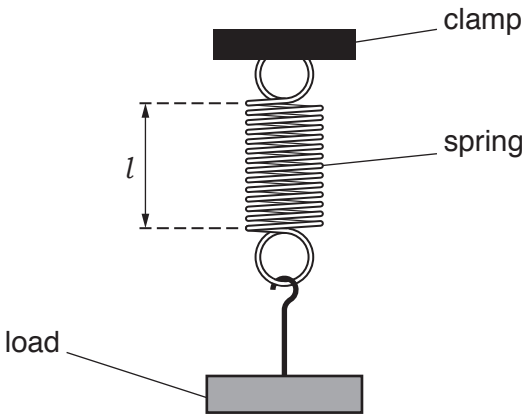


Fig. 3.1

(a) The stretched length l of the spring, indicated in Fig. 3.1, is to be measured.

Describe **two** precautions that could be taken when measuring the length of the stationary spring, to ensure an accurate reading. You may draw a diagram.

1 .....

.....

2 .....

.....

[2]

(b)

- A student measures the length l_0 of the spring without any load.

l_0 = ...2.1..... cm

- Various loads L are hung on the spring.
  The stretched length l of the spring for each load is recorded in Table 3.1.

Table 3.1

L/N	l/cm	e/cm
1.0	6.3	
2.0	10.5	
3.0	14.7	

- Calculate, and record in Table 3.1, the extension e of the spring for each load L.
  Use the equation $e = (l - l_0)$.

[1]

(c) The loads are removed and an object **X** is suspended from the spring.

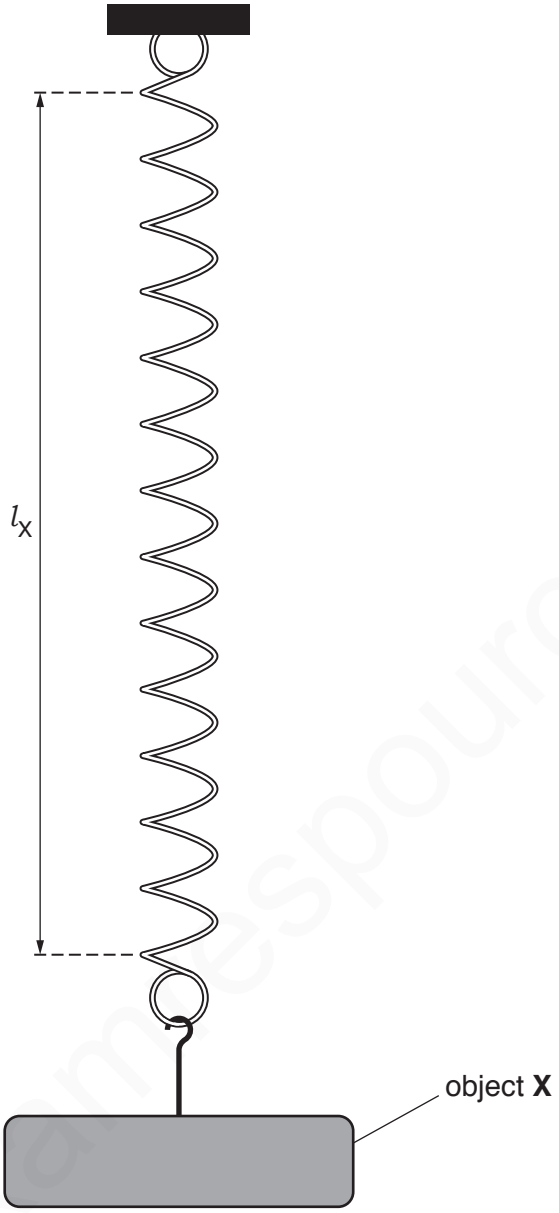


Fig. 3.2

(i) Measure the stretched length l_X of the spring on Fig. 3.2.

l_X = ... cm [1]

(ii) Estimate the weight W_X of object **X**.
Explain how you obtained your answer.

.....

.....

.....

W_X = ... N [2]

(d) A student measures the weight of a different load using a similar method. He gives the weight as 4.532 N.
Explain why this is not a suitable number of significant figures for this experiment.

.....

.....

..... [1]

(e) **(i)** Another student suggests that *e* is directly proportional to *L*.
State whether the results support her suggestion.
Use values from the results in Table 3.1 to justify your statement.

statement .....

justification .....

.....

.....
[2]

(ii) The student wishes to plot a graph of *L* against *e* to test if the two quantities are directly proportional.
State how her graph line could show that *e* is directly proportional to *L*.

.....

.....

..... [2]

[Total: 11]

MARKING SCHEME

3(a)	any **two** from: • rule close / parallel to spring ; • eye perpendicular to reading / use set square ; • clamp rule	**2**
3(b)	correct calculations of *e* (4.2, 8.4, 12.6)	**1**
3(c)(i)	l_x = 11.4(cm)	**1**
3(c)(ii)	2.0 N < W_x < 2.5(N)	**1**
	working showing use of ratio/correct logic	**1**
3(d)	data only given to 1 dp / 2 or 3 sig fig	**1**
3(e)(i)	statement matching results	**1**
	correct justification matching statement e.g. • *L*/*e* constant • *e* doubles when *L* doubles	**1**
3(e)(ii)	straight line	**1**
	(line) through origin	**1**

4 A student is investigating the stretching of a spring.

The apparatus is shown in Fig. 1.1.

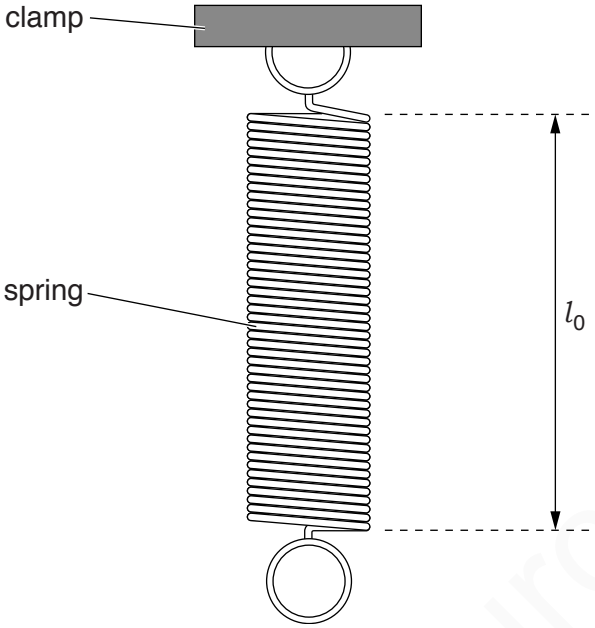


Fig. 1.1

(a) On Fig. 1.1, measure the unstretched length l_0 of the spring. Record l_0 in the first row of Table 1.1. [1]

(b) The student hangs a load L of 1.0 N on the spring and measures the new length l of the spring. She repeats the measurements using loads of 2.0 N, 3.0 N, 4.0 N and 5.0 N. The readings are shown in Table 1.1.

(i) For each set of readings, calculate the extension e of the spring using the equation $e = (l - l_0)$. Record the values of e in the table.

Table 1.1

L/N	l/mm	e/mm
0.0		0
1.0	59	
2.0	64	
3.0	69	
4.0	74	
5.0	78	

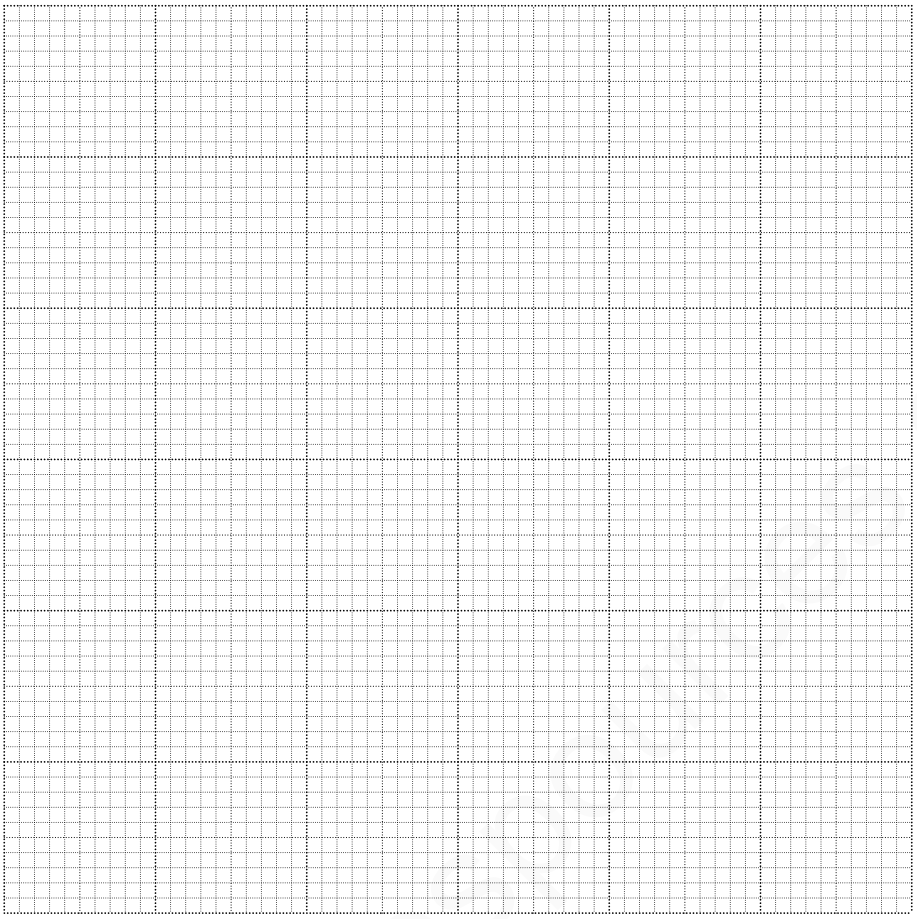
[1]

(ii) Explain briefly one precaution that you would take in order to obtain reliable readings.

.....

.....[1]

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



[4]

(d) The student removes the load from the spring and hangs an unknown load **X** on the spring. She measures the length l of the spring.

l = 72 mm

(i) Calculate the extension e of the spring.

e = ... [1]

(ii) Use the graph to determine the weight W of the load **X**. Show clearly on the graph how you obtained the necessary information.

W = ... [2]

[Total: 10]

MARKING SCHEME

(a)	l_0 = 55 (mm) c.a.o.	**1**
(b)(i)	4, 9, 14, 19, 23 ecf **(a)**	**1**
(b)(ii)	Viewing scale at right angles or use of straight edge / set square / pointer between bottom of spring and scale / ruler	**1**
(c)	Graph: Axes correctly labelled with quantity and unit Suitable scales All plots correct to ½ small square Good line judgement, thin, continuous line, neat plots	 **1** **1** **1** **1**
(d)(i)	e = 17 (mm) ecf **(a)**	**1**
(d)(ii)	method clearly shown on graph W value 3.5–3.75 Unit N needed No ecf from **(i)**	**1** **1**
		Total: 10

5 The class is investigating the stretching of a spring.

Fig. 1.1 shows the apparatus.

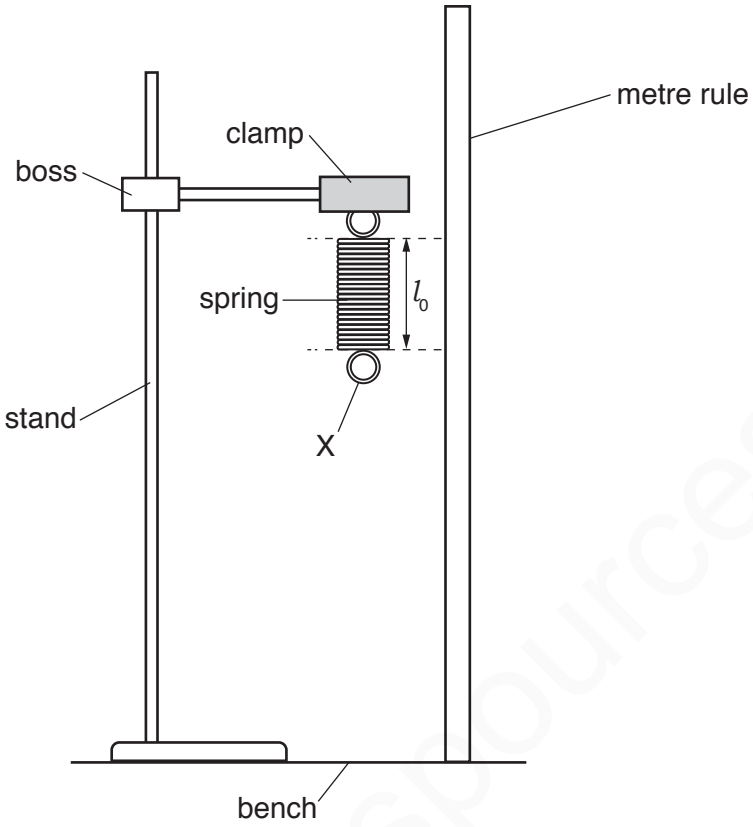


Fig. 1.1

(a) **(i)** On Fig. 1.1, measure the length l_0.
Record l_0 in Table 1.1 at load $L = 0.0$ N. [1]

(ii) Explain why l_0 is **not** measured to point X on the spring.

.....

.....[1]

(b) A student hangs a 1.0 N load on the spring. He records the new length l of the spring.

He repeats the procedure using loads of 2.0 N, 3.0 N, 4.0 N and 5.0 N. The readings are shown in Table 1.1.

Table 1.1

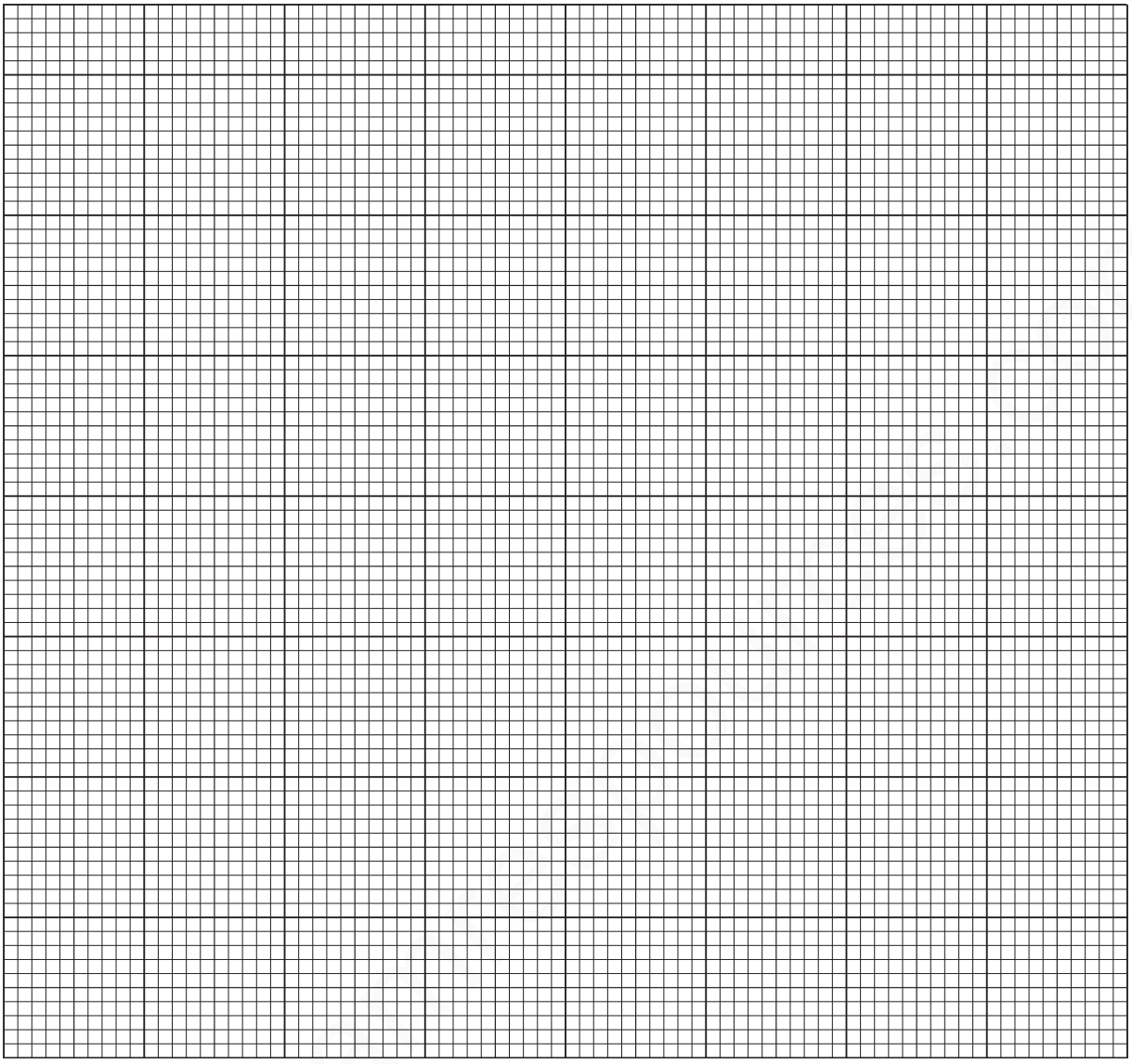
L/N	0.0	1.0	2.0	3.0	4.0	5.0
l/mm		17	20	21	23	25

Describe **one** precaution that you would take in order to obtain reliable readings.

.....

.....[1]

(c) Plot a graph of l/mm (y-axis) against L/N (x-axis).



[4]

(d) A student suggests that the length l of the spring is directly proportional to the load L.

State whether your readings support this suggestion. Justify your answer by reference to the graph line.

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.....[1]

(e) Use the results to predict the load L that would give a length l twice the value of l_0.
Show clearly how you obtained your answer.

load L = ...[2]

MARKING SCHEME

(a)(i)	15	1
(a)(ii)	Ring(s) do not extend (owtte)	1
(b)	Use of set square to line up with scale OR perpendicular viewing	1
(c)	Graph:	
	Axes correctly labelled and right way round	1
	Suitable scales	1
	All 6 plots correct to ½ small square	1
	Good line judgement, thin, single, continuous line	1
(d)	(NO);line does not pass through origin	1
(e)	*L* in range 6–8	1
	L in range 7.2–7.8	1
	Total:	10