STRETCHING OF SPRINGS

1 The IGCSE class is investigating the stretching of springs.

Each student is able to use a selection of different springs, a set of slotted masses to hang on the end of a spring, a metre rule, and any other common laboratory apparatus that may be useful.

A student decides to investigate the effect of the type of metal from which the spring is made on the extension produced by loading the spring.

(a) Suggest three possible variables that should be kept constant in this investigation. (Do not include variables that are likely to have very little effect on the length of a spring in this context.)

1. ....

2. ....

3. .... [3]

(b) In the investigation, the original length l_0 of a spring is measured and then the new length l when a load is attached. Fig. 5.1 shows an unloaded spring and the same spring with a load attached. On Fig. 5.1, show clearly the original length l_0 and the new length l.

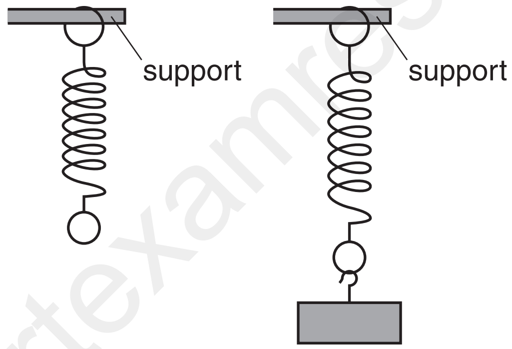


Fig. 5.1

[1]

(c) It is not possible to position a metre rule immediately next to the spring. Describe briefly how you would overcome this problem when measuring the length l. You may draw a diagram.

....

.... [1]

[Total: 5]

(a) three from:
length/diameter/number of coils of spring – any two for 1 mark each
mass of spring
selection of loads
(NOT room temperature) [3]

(b) l_o shown and l shown (consistent with l_o) [1]

(c) use of fiducial aid [1]

[Total: 5]

2 The IGCSE class is investigating springs.

A student measures the length l_0 of a spring and then uses a stand and clamp to suspend the spring vertically. He hangs a weight W on the spring and measures the new length l. He calculates the extension e of the spring. He repeats the procedure using a range of weights.

Table 5.1 shows some readings obtained by the student. The unstretched length l_0 of the spring is 16 mm.

Table 5.1

W/N		
0	16	0
0.10	17	
0.20	19	
0.30	21	
0.40	23	
0.50	27	
0.60	33	

(a) Complete the column headings in Table 5.1. [1]

(b) Complete the third column in the table by calculating the extension *e* of the spring. [1]

(c) State whether the results support the suggestion that the extension is directly proportional to the load. Justify your answer by reference to the results.

statement ....

justification ....

....

....[2]

(d) Draw a diagram of the apparatus including the spring, clamp, a weight hanging on the spring and a ruler positioned to measure the length of the spring.

[2]

[Total: 6]

(a) l / mm, e / mm or in words [1]

(b) 1, 3, 5, 7, 11, 17 [1]

(c) no [1]
larger loads produce bigger increases in extension OR increase between (successive) extensions not the same OR ratio W/e not the same [1]

(d) clamp, spring and weight sensibly shown [1]
ruler close to spring or with suitable horizontal pointer or equivalent [1]

[Total: 6]

3 The IGCSE class is investigating the stretching of a spring.

Fig. 1.1 shows the experimental set up.

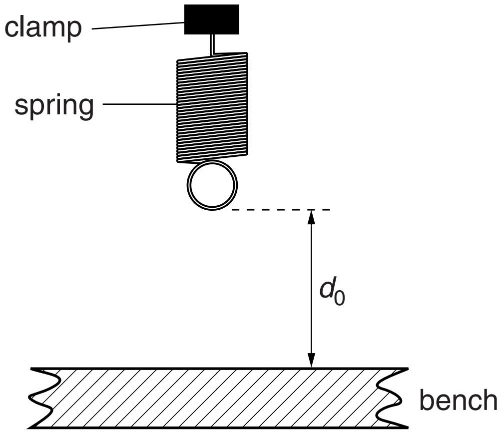


Fig. 1.1

(a) On Fig. 1.1, measure the vertical distance d_0, in mm, between the bottom of the spring and the surface of the bench.

d_0 = ... mm [1]

(b) The diagram is drawn 1/10th actual size. Calculate the actual distance D_0, in mm, between the bottom of the spring and the surface of the bench.

D_0 = ... mm [1]

(c) A student hangs a 1.0 N load on the spring. He measures and records the distance *D* between the bottom of the spring and the surface of the bench, and the value of the load *L*.

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

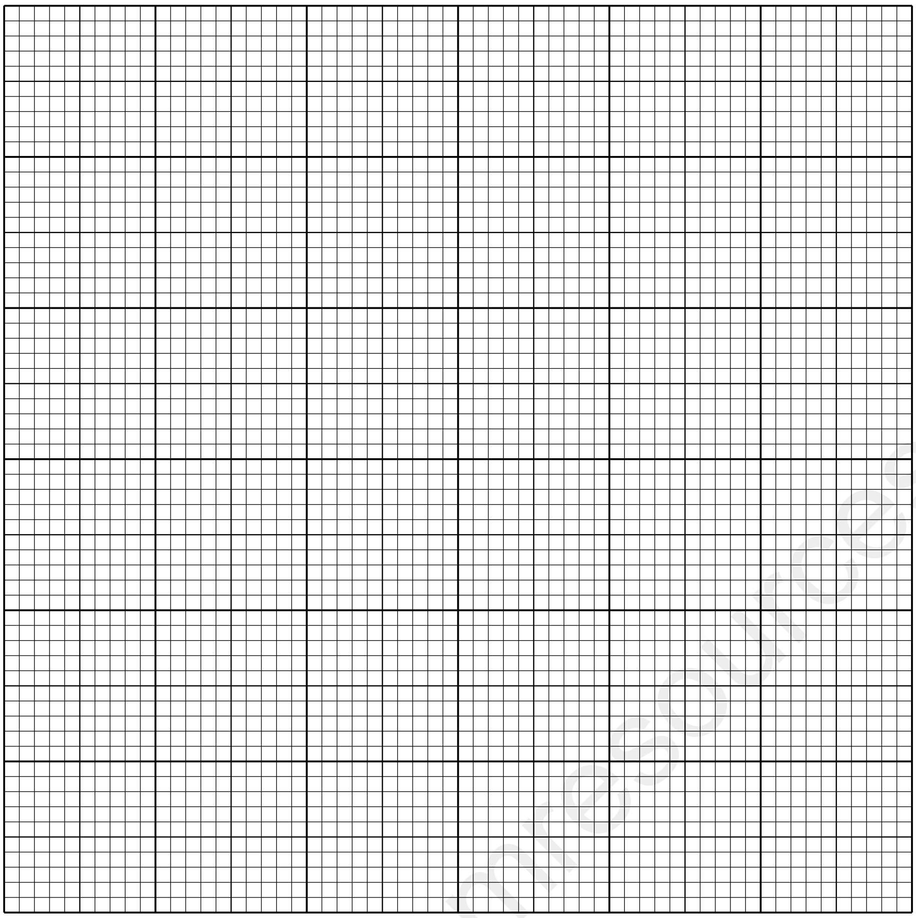
Calculate the extension *e* of the spring, for each set of readings, using the equation $e = (D_0 - D)$. Record the values of *L* and *e* in Table 1.1.

Table 1.1

L / N	*D* / mm	*e* / mm
	199	
	191	
	179	
	171	
	160	

[2]

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



[4]

(e) Determine the gradient G of the graph. Show clearly on the graph how you obtained the necessary information.

G = ... [2]

(f) When making measurements, the student is careful to avoid a line-of-sight error.

Suggest one other precaution that the student should take when measuring the distance D between the bottom of the spring and the surface of the bench.

....

.... [1]

[Total: 11]

(a) d_0 = 21 (mm) [1]

(b) D_o = 210 (mm) or 10 × candidate's **(a)** [1]

(c) *L* values 1.0, 2.0, 3.0, 4.0, 5.0 [1]
e values 1.0, 9.0, 21.0, 29.0, 40.0 [1]

(d) Graph:
Axes correctly labelled with quantity and unit and correct way around [1]
Suitable scales [1]
All plots correct to ½ small square
Good line judgement <u>and</u> a single, thin, continuous line [1]

(e) Triangle method used and shown on the graph [1]
Using at least half of line [1]

(f) Any one from:
Always measure from same point on spring (top or bottom of ring)
Wait for spring/weight to stop bouncing
Use of horizontal aid/ensure ruler is vertical
Bench surface not uniform [1]

[Total: 11]

4 The IGCSE class is investigating the stretching of a spring.

Fig. 5.1 shows the apparatus.

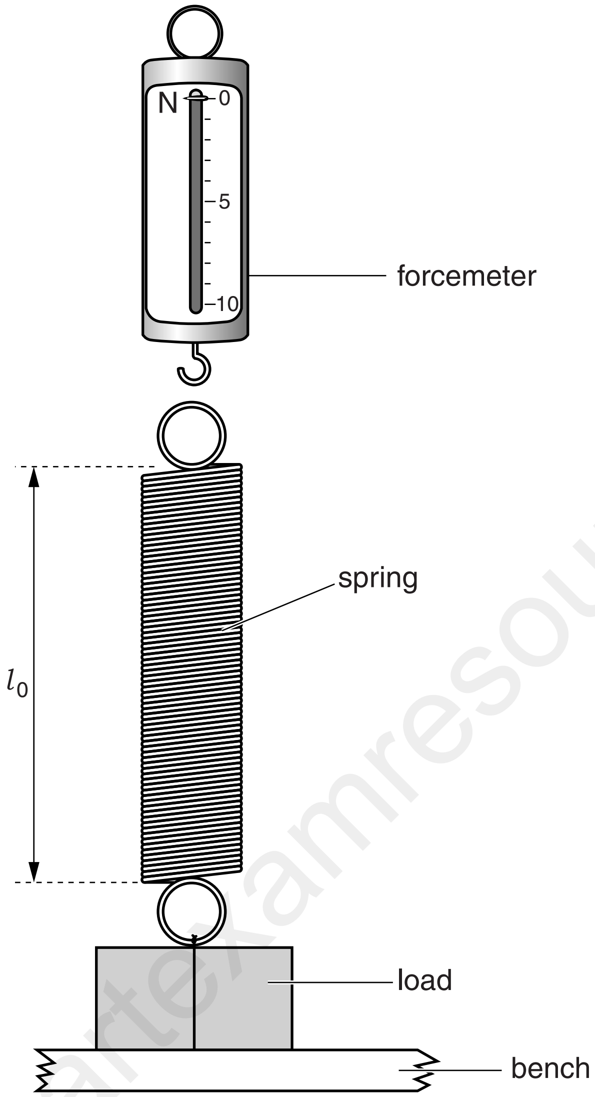


Fig. 5.1

(a) On Fig. 5.1, measure the unstretched length l_0 of the spring, in mm.

l_0 = ... mm [1]

(b) A student hangs the spring on the forcemeter with the load attached to the bottom of the spring, as shown in Fig. 5.1. The load remains on the bench.

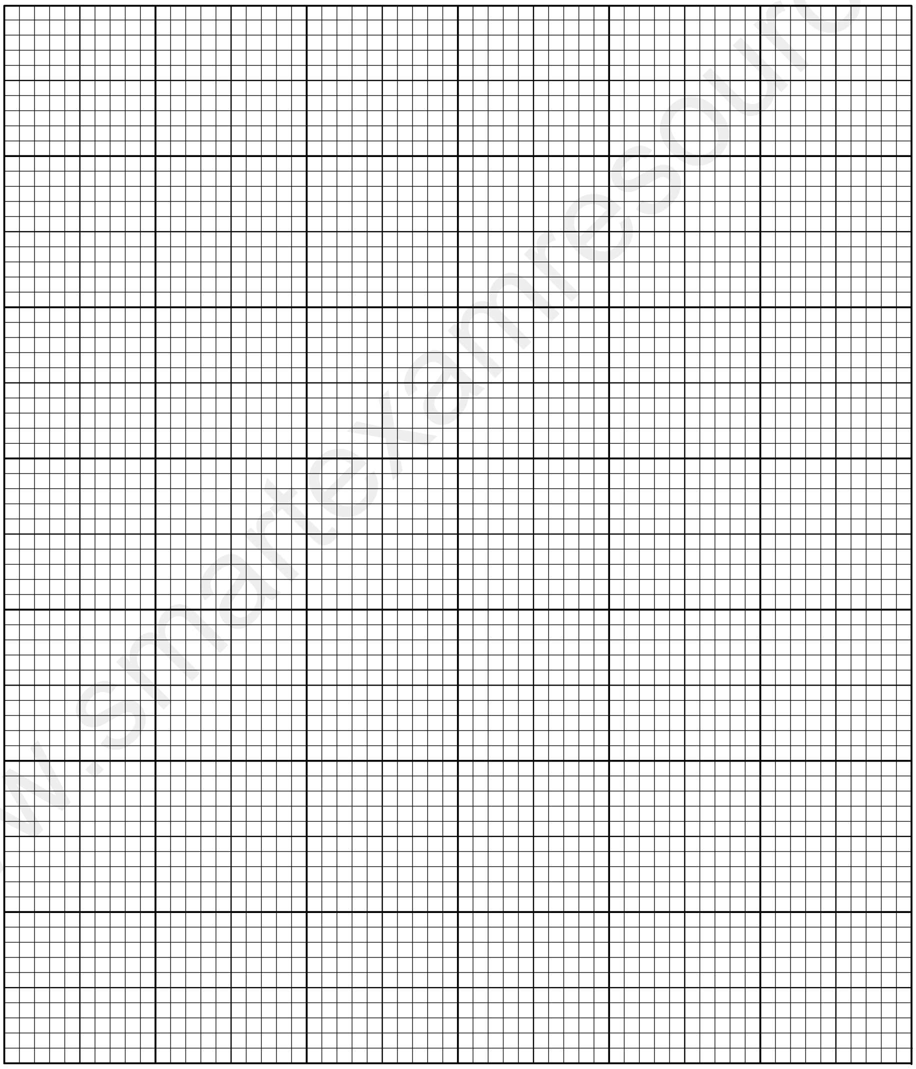
He gently raises the forcemeter until it reads 1.0 N. He measures the new length l of the spring. He repeats the procedure using a range of forcemeter readings. The readings are recorded in Table 5.1.

Table 5.1

F/N	l/mm	e/mm
1.0	67	
2.0	77	
3.0	91	
4.0	105	
5.0	115	

(i) Calculate the extension e of the spring, for each set of readings, using the equation $e = (l - l_0)$. Record the values of e in Table 5.1. [1]

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



[5]

(iii) Determine the gradient *G* of the graph. Show clearly on the graph how you obtained the necessary information.

G = ... [2]

[Total: 9]

(a) 54 – 55 [1]

(b) (i) table:
e values 12, 22, 36, 50, 60 (e.c.f. from **(a)**) [1]

(ii) graph:
axes correctly labelled *e* / mm and *F* / N and correct way round [1]
suitable scales [1]
all plots correct to ½ small square [1]
good line judgement [1]
thin, single continuous line [1]

(iii) triangle method using at least half of candidate's line, shown on the graph [1]
G = 11 – 13, no e.c.f. [1]

[Total: 9]

5 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. 2.1.

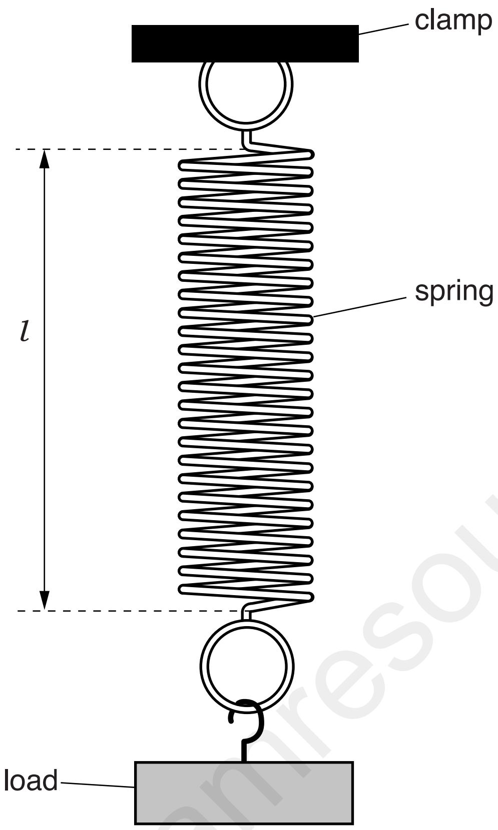


Fig. 2.1

(a) A load of weight L = 1.0 N is hung on the spring. The stretched length l of the spring, as indicated in Fig. 2.1, is recorded in Table 2.1.

Suggest a precaution that you would take when measuring the length of the spring, to ensure a reliable reading. You may draw a diagram.

....

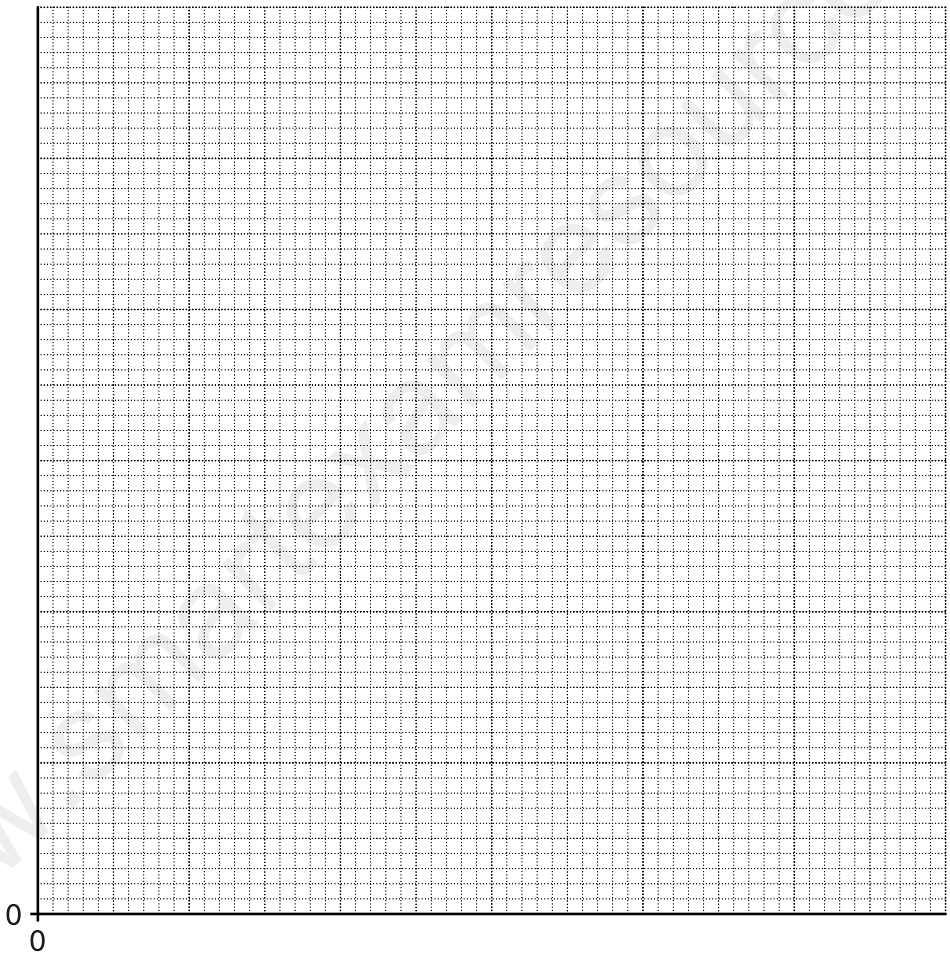
....[1]

b) Step **(a)** is repeated for values of L = 2.0 N, 3.0 N, 4.0 N and 5.0 N. The readings are shown in Table 2.1.

Table 2.1

L/N	l/cm
1.0	6.1
2.0	9.0
3.0	13.4
4.0	16.8
5.0	21.0

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



[4]

(c) Use your graph to determine the length l_0 of the spring with no load attached.

l_0 = ...[1]

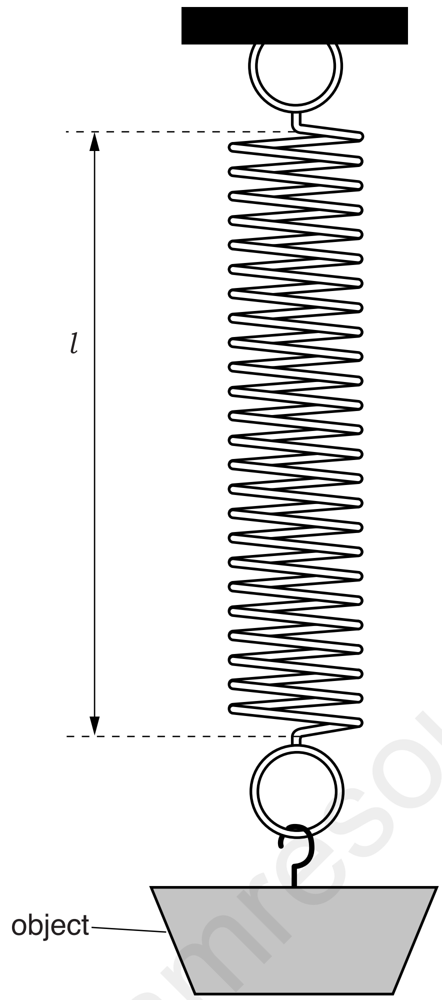


Fig. 2.2

(d) The loads are removed and an object is suspended from the spring, as shown in Fig. 2.2.

(i) On Fig. 2.2, measure the stretched length l of the spring.

l = ...[1]

(ii) Use the graph, and your reading from **(d)(i)**, to determine the weight W of the object. Show clearly on the graph how you obtained your answer.

W = ... N
[2]

(e) A student measures the weight of a different load using this same method. He gives the weight as 2.564 N.

Explain why this is not a suitable number of significant figures for this experiment.

....

....

....[1]

[Total: 10]

(a) any one from: [1]
- clamp rule
- rule close to spring
- ensure rule vertical
- avoidance of parallax errors (explained)
- use of set square/ fiducial aid

(b) graph:
- axes both correctly labelled, right way round and with units [1]
- suitable scales [1]
- all plots correct to within ½ small square [1]
- good best-fit straight line, single, thin, continuous line [1]

(c) value consistent with candidate's graph [1]

(d) **(i)** 8(.0) (cm) [1]

(ii) W = 1.4–1.7 (N) [1]
indication on graph which matches candidate's value [1]

(e) any one from: [1]
- data only to 2 sig. figs.
- cannot plot/ read graph to that level of accuracy
- cannot read rule to that level of accuracy

[Total 10]