1.5 Forces

01. 0625_p20_qp_60 Q: 1

A student is determining the mass of a load using a balancing method.

Fig. 1.1 shows the apparatus.

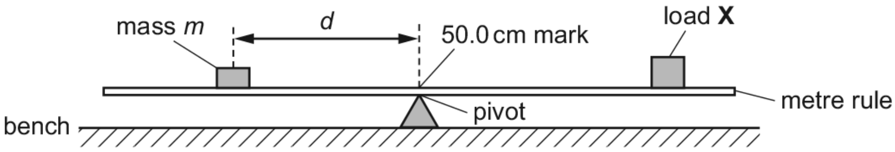

Fig. 1.1

The load **X** has been taped to the metre rule so that its centre is exactly over the 90.0 cm mark. It is not moved during the experiment.

A mass *m* of 40 g is placed on the rule and its position adjusted so that the rule is as near as possible to being balanced with the 50.0 cm mark exactly over the pivot. Fig. 1.2(a) shows part of the rule when it is balanced.

The procedure is repeated for a range of masses. Fig. 1.2(b)–(e) shows the rule when balanced for values of *m* of 50 g, 60 g, 70 g and 80 g.

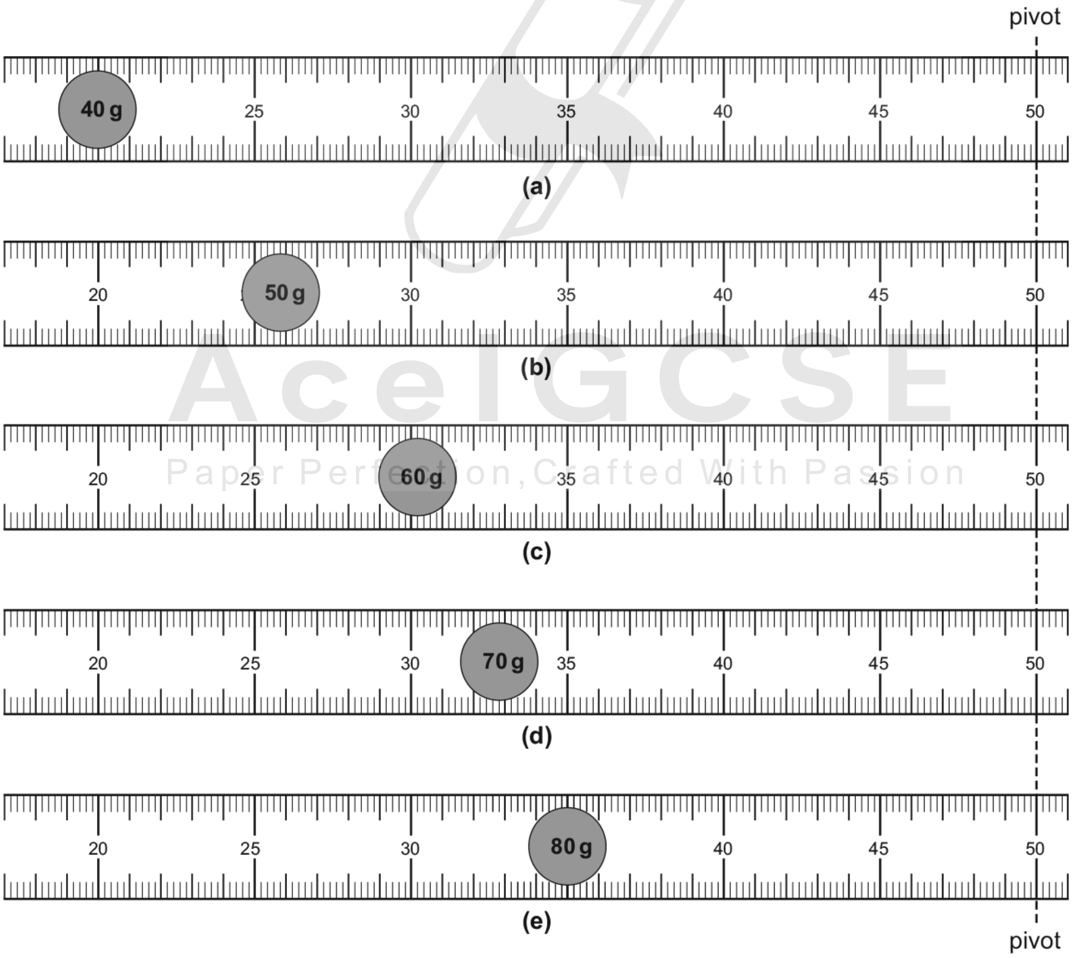

Fig. 1.2

(a) (i) Use Fig. 1.2 to determine *d*, the distance between the mass and the pivot at balance, for each value of *m*. Record your results in Table 1.1. [3]

Table 1.1

m / g	d / cm	$\frac{1}{d} \Big/ \frac{1}{\text{cm}}$
40		
50		
60		
70		
80		

(ii) For each value of *d*, calculate 1 / *d* and record it in the table. [1]

(b) Describe one difficulty the student might have when carrying out this experiment, and how he might overcome this difficulty.

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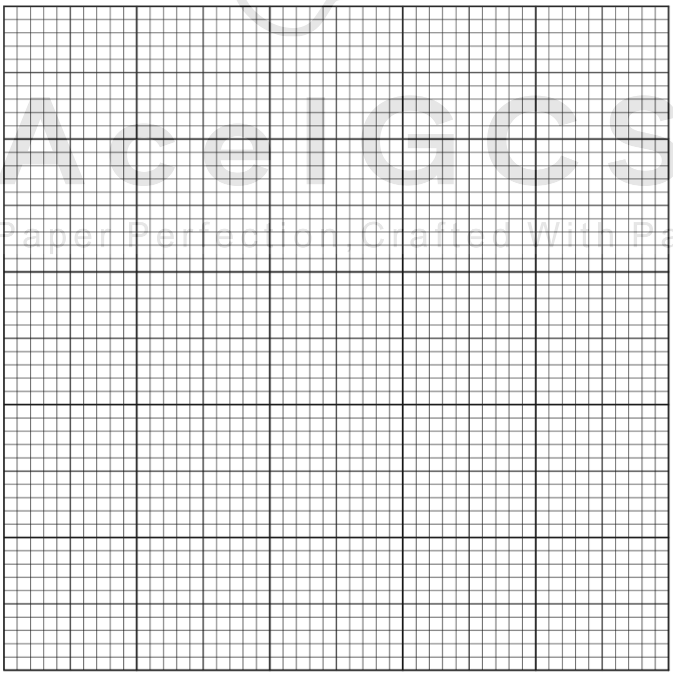
.... [2]

(c) Plot a graph of *m* / g (*y*-axis) against $\frac{1}{d} \Big/ \frac{1}{\text{cm}}$ (*x*-axis).



[4]

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

G = ... [1]

(e) Determine the mass μ, in grams, of the load **X**. Use the equation $\mu = \frac{G}{40.0}$.

μ = ... g [1]

[Total: 12]

02. 0625_p20_qp_60 Q: 4

A student's plastic bottle of water tips over in class.

Plan an experiment to investigate how the quantity of water in a plastic bottle affects its stability.

The plastic bottle holds up to 2000 cm^3 of water and has a height of 42 cm.

(a) Write a plan for the experiment, including:

- the apparatus needed
- instructions for carrying out the experiment
- the values you will use for the quantity of water
- how you will make sure your results are as accurate as possible
- the graph you will plot from your results

A diagram is not required, but you may add to Fig. 4.1, or draw your own diagram, if it helps to explain your plan.

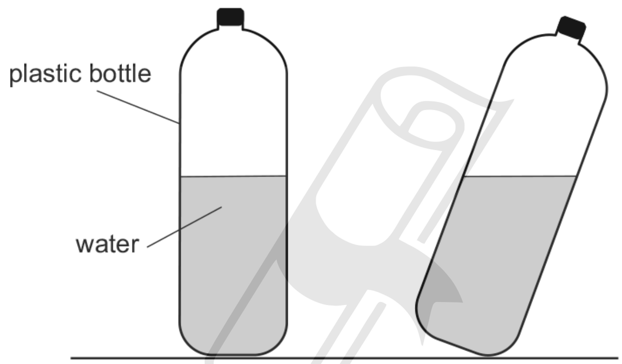


Fig. 4.1

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....[7]

(b) On Fig. 4.1, measure the angle through which the bottle has been tilted.

angle = ... [1]

[Total: 8]

03. 0625_s20_qp_61 Q: 1

A student investigates the balancing of a metre rule.

Fig. 1.1 shows the arrangement.

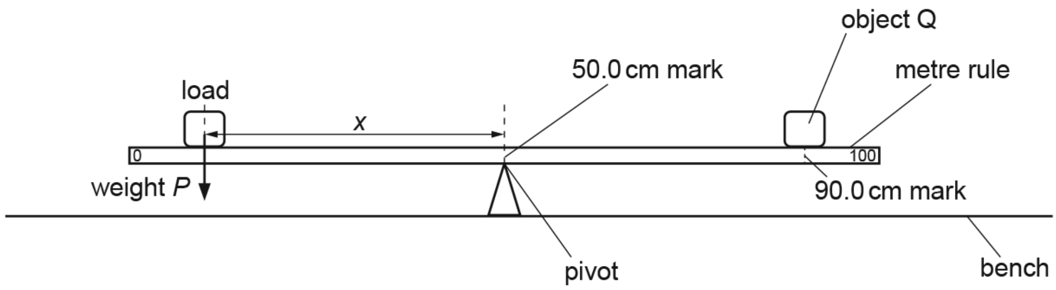


Fig. 1.1

(a) The student places the metre rule on the pivot at the 50.0 cm mark. He places an object Q on the metre rule with its centre at the 90.0 cm mark. He places a load of weight P = 2.0 N on the metre rule and adjusts the position of the load so that the metre rule is as near as possible to being balanced.

He measures the distance x from the centre of the load to the pivot.

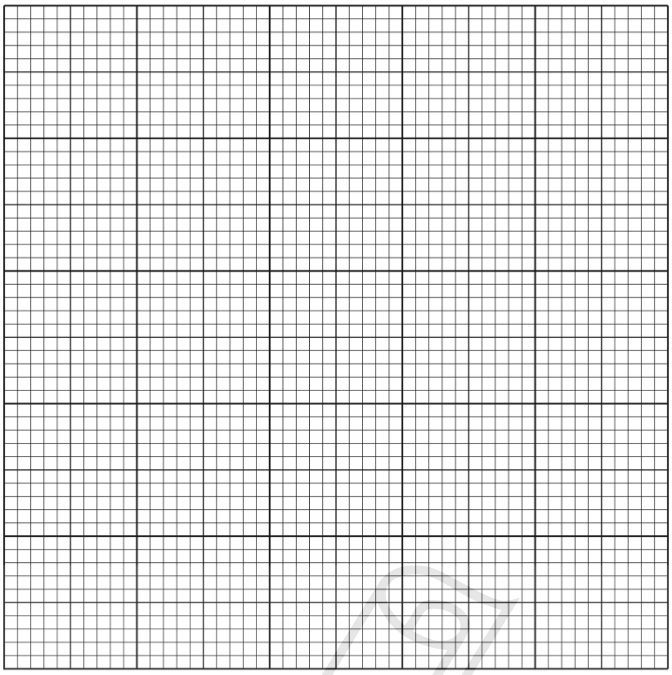
He repeats the procedure using loads of weight P = 3.0 N, 4.0 N, 5.0 N and 6.0 N. All the values of P and x are recorded in Table 1.1.

Table 1.1

P/N	x/cm	$\frac{1}{x}\Big/\frac{1}{\text{cm}}$
2.0	40.0	
3.0	27.0	
4.0	20.0	
5.0	15.9	
6.0	13.3	

Calculate, and record in Table 1.1, the values of $\frac{1}{x}$. [2]

(b) Plot a graph of P/N (y-axis) against $\frac{1}{x} \Big/ \frac{1}{\text{cm}}$ (x-axis). Start both axes at the origin (0,0).



[4]

(c) In this experiment, x_{max}, the maximum possible value for x is 50.0 cm. Calculate $\frac{1}{x_{max}}$.

$\frac{1}{x_{max}}$ = ... $\frac{1}{\text{cm}}$

Use the graph to determine the minimum value of P required to balance the metre rule in this experiment. Show clearly on the graph how you determined this value.

minimum value of P = ... [2]

(d) In this experiment, the width of object Q is slightly greater than the width of the metre rule. Explain briefly how you would place the object Q as accurately as possible on the 90.0 cm mark of the metre rule. You may draw a diagram.

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.... [1]

(e) In this experiment, it is difficult to determine the exact position of the load that will make the metre rule balance.

(i) Explain briefly why this is difficult.

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.... [1]

(ii) Explain briefly how you would find the best position of the load that will make the metre rule balance.

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.... [1]

[Total: 11]

04. 0625_s20_qp_62 Q: 4

A student investigates the bending of 1 m length strips of different materials. She compares how far they bend when loaded at one end.

Plan an experiment to investigate how the material from which the strips are made affects the bending of the strips when loaded at one end.

The following apparatus is available to the student:

strips of wood, plastic, steel and aluminium, each of length 1 m
a set of slotted masses
a metre rule
a G-clamp (used to hold the strips to the laboratory bench).

Other apparatus normally available in a school laboratory can also be used.

In your plan, you should:

- draw a diagram to show the arrangement of the apparatus
- explain briefly how you would carry out the investigation, including the measurements you would take
- state the key variables to be kept constant
- draw a suitable table, with column headings, to show how you would display your readings (you are **not** required to enter any readings in the table)
- explain how you would use the results to reach a conclusion.

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[Total: 7]

05. 0625_s20_qp_63 Q: 1

A student determines the weight of a metre rule.
She uses the apparatus shown in Fig. 1.1.
The metre rule is supported by a pivot **at the 10.0 cm mark** and is suspended from a forcemeter by a loop of thread at the 90.0 cm mark.

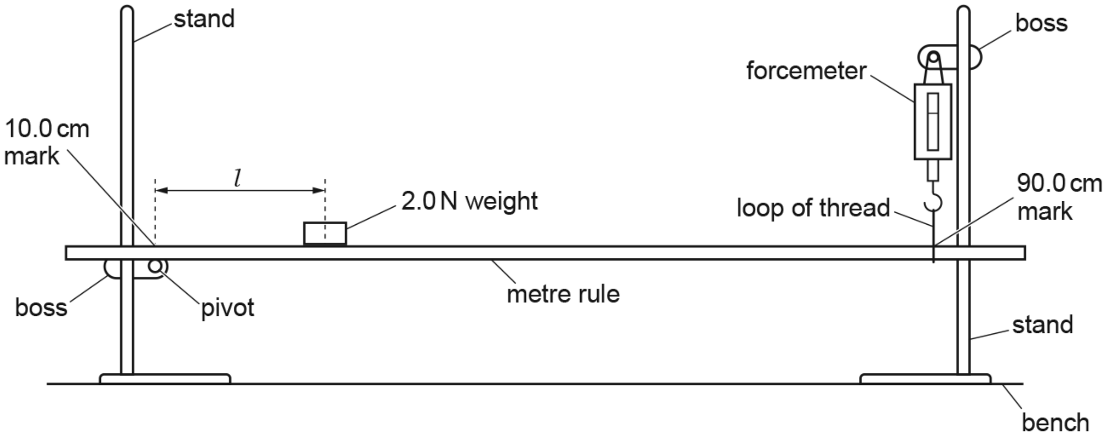

Fig. 1.1

(a) The student places a 2.0 N weight at a distance l from the pivot.
She then adjusts the height of the clamp holding the pivot so that the metre rule is horizontal.
She reads the force F on the forcemeter.
Fig. 1.2 shows the weight and the metre rule from above.
Fig. 1.3 shows the reading on the forcemeter.

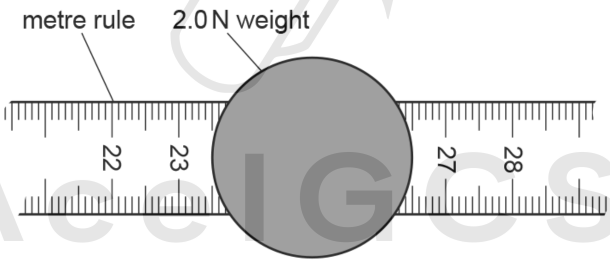

Fig. 1.2 (not to scale)

(i) Calculate the value of l from readings taken from Fig. 1.2.
Show your working clearly.

l = ... cm [2]

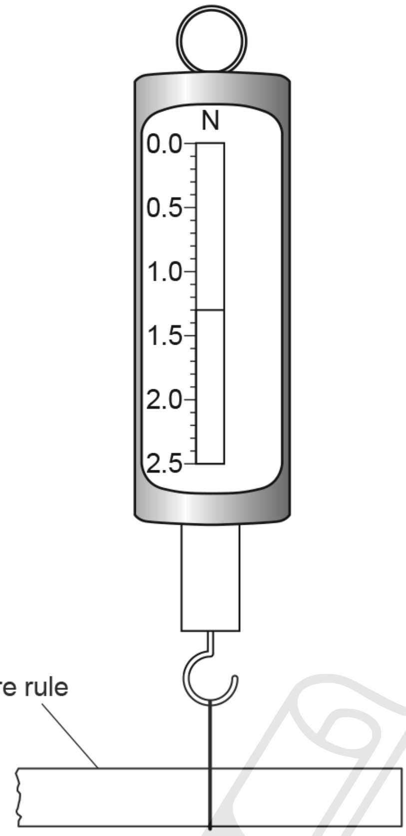

Fig. 1.3

(ii) Read the value *F* shown on the forcemeter in Fig. 1.3.

F = ... N [1]

(iii) Explain how the student makes sure that the rule is horizontal before taking the reading. You may draw a diagram.

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.... [1]

(b) The student carries out the procedure for values of l = 20.0 cm, 30.0 cm, 40.0 cm, 50.0 cm and 60.0 cm. Her readings are shown in Table 1.1.

Table 1.1

l / cm	F / N
20.0	1.35
30.0	1.60
40.0	1.90
50.0	2.15
60.0	2.45

Plot a graph of F / N (y-axis) against l / cm (x-axis).
Start your axes from the origin (0,0).

[4]

(c) **(i)** From your graph determine F_0, the value of F when l = 0.

F_0 = ... N [1]

(ii) Calculate the weight W_R of the metre rule, using the equation $W_R = 2 \times F_0$.

W_R = ... N [1]

(d) Another student carrying out this experiment finds it difficult to be sure that he has placed the centre of the 2.0 N weight on the metre rule at the correct value of l.

Suggest a more precise method of applying a 2.0 N load to the metre rule in this experiment. Explain why this method is an improvement.

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....

.... [1]

[Total: 11]

06. 0625_m19_qp_62 Q: 4

A student wants to investigate the effect of air resistance on the swing of a pendulum.

Plan an experiment which will enable him to investigate how air resistance changes the way in which a pendulum swings.

The apparatus available includes:

a light wooden rod, approximately 80 cm long with a hole at one end, through which a nail will fit
a piece of modelling clay to act as a pendulum bob, as shown in Fig. 4.1
a sheet of thick card which will provide the air resistance when the pendulum swings.

In your plan, you should:

- list any additional apparatus needed
- explain briefly how you would carry out the experiment including exactly which measurements should be taken
- 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 how you would use your readings to reach a conclusion.

You may add to Fig. 4.1 or draw an additional diagram if it helps to explain your plan.

Fig. 4.1

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....

[7]

[Total: 7]

07. 0625_s19_qp_61 Q: 1

A student is determining the weight of a metre rule using a balancing method.

Fig. 1.1 shows the apparatus.

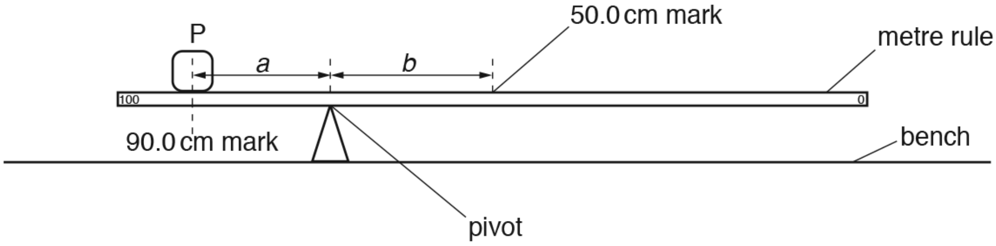


Fig. 1.1

The student places the metre rule on the pivot. He places the load P on the metre rule at the 90.0 cm mark. Keeping load P at the 90.0 cm mark, he adjusts the position of the metre rule on the pivot so that the metre rule is as near as possible to being balanced.

He records the distance *a* from the 90.0 cm mark to the pivot.

He records the distance *b* from the pivot to the 50.0 cm mark.

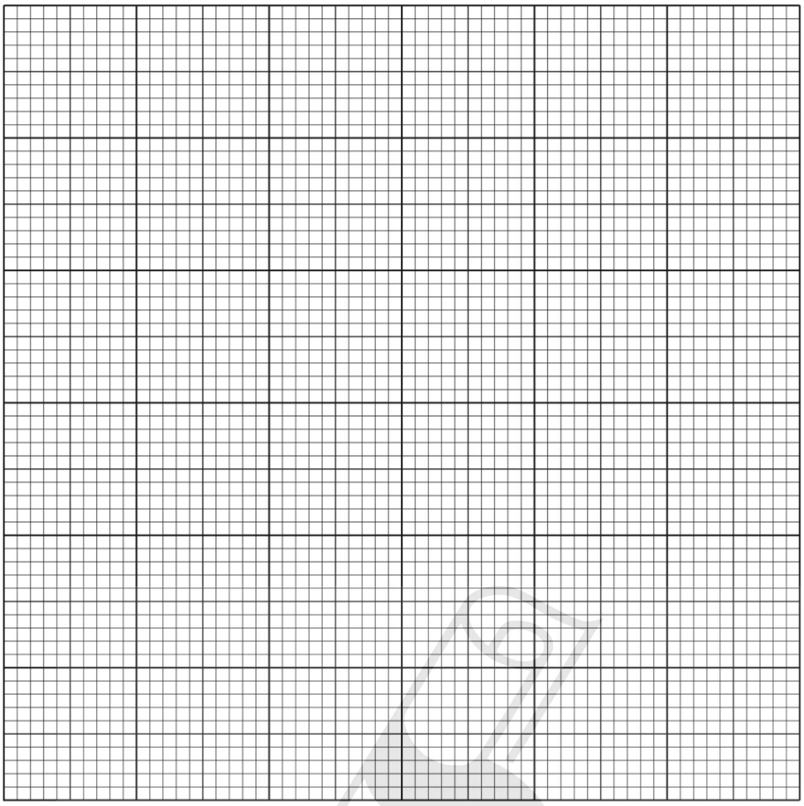
He repeats the steps, placing the load P at the 85.0 cm, the 80.0 cm, the 75.0 cm and the 70.0 cm marks.

The readings are shown in Table 1.1.

Table 1.1

a / cm	*b* / cm
21.0	19.1
18.0	17.2
16.0	14.1
13.0	11.8
10.5	9.5

(a) Plot a graph of a/cm (y-axis) against b/cm (x-axis). You do **not** need to begin your axes at the origin (0,0).



[4]

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

G = ... [2]

(c) Calculate the weight W_1 of the metre rule using the equation $W_1 = G \times P$, where P = 1.0 N.

W_1 = ... [2]

(d) Suggest **one** practical reason why it is difficult to obtain accurate readings for a and b in this type of experiment.

....

.... [1]

(e) The student measures the mass of the rule on a balance. Write down the mass *m* shown on the balance in Fig. 1.2 to the nearest gram.

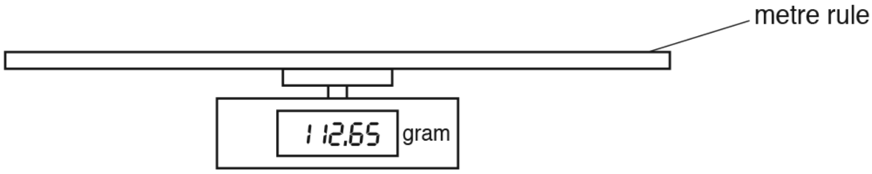


Fig. 1.2

m = ... g [1]

(f) **(i)** Calculate the weight W_2 of the metre rule using the equation $W_2 = mg$, where $g = 10.0$ N/kg.

W_2 = ... N [1]

(ii) State and explain whether this value of W_2 can be considered equal to the value of W_1 obtained in part **(c)** within the limits of experimental accuracy.

....

.... [1]

[Total: 12]

08. 0625_s19_qp_62 Q: 1

A student is investigating moments using a balancing method.

Fig. 1.1 shows the apparatus.

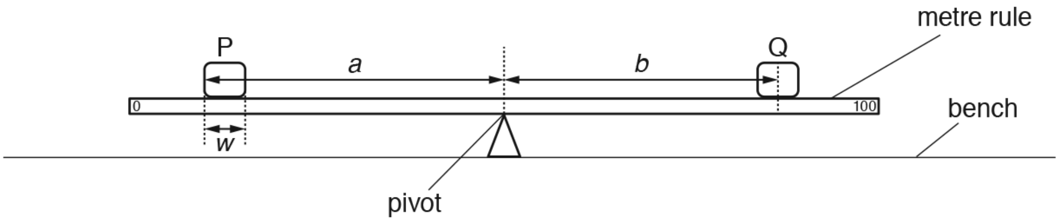


Fig. 1.1

(a) The student places the metre rule, without the loads, on the pivot and adjusts its position so that the metre rule is as near as possible to being balanced. She keeps the rule at this position on the pivot throughout the experiment.

Explain briefly why this position on the pivot may not be exactly at the 50.0 cm mark of the rule.

....

.... [1]

(b) She places a load P on the metre rule so that the **edge** that is furthest from the pivot is exactly at the 10.0 cm mark on the rule.

She measures the distance *a* between this **edge** of the load P and the pivot, as shown in Fig. 1.1.

She places a load Q on the metre rule and adjusts the position of load Q so that the metre rule is as near as possible to being balanced.

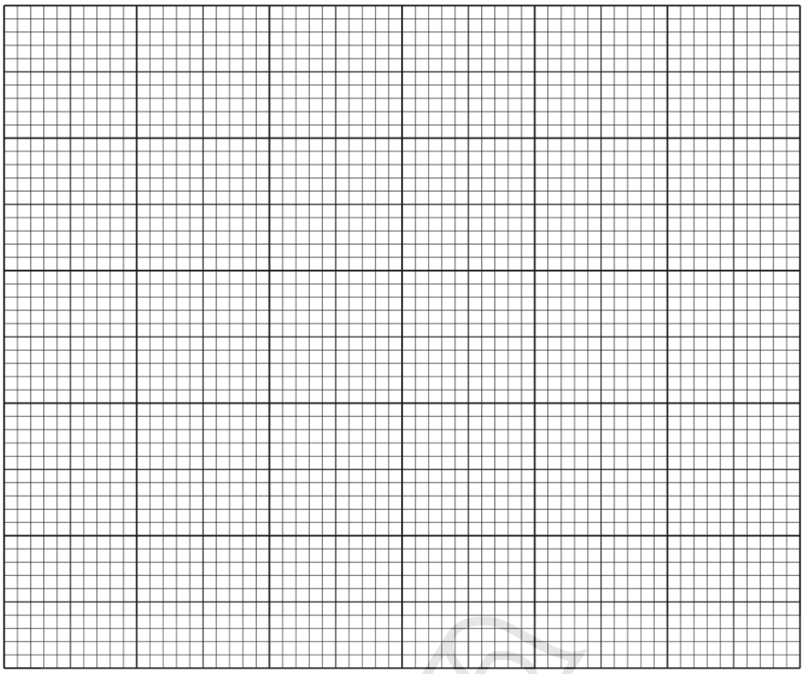
She measures the distance *b* between the **centre** of load Q and the pivot, as shown in Fig. 1.1.

She repeats the procedure, with the **edge** of the load P that is furthest from the pivot at the 15.0 cm, 20.0 cm, 25.0 cm and 30.0 cm marks. All the readings are shown in Table 1.1.

Table 1.1

a / cm	*b* / cm
38.0	44.5
33.0	38.5
28.0	33.6
23.0	27.2
18.0	22.0

Plot a graph of a/cm (y-axis) against b/cm (x-axis). Start both axes at the origin (0,0).



[4]

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

G = ... [2]

(d) Determine the intercept C on the x-axis of the graph. This is the value of b when a = 0.

C = ... [1]

(e) On Fig. 1.2, measure the width w of the load P.

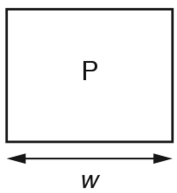


Fig. 1.2

w = ... [1]

(f) Another student suggests that the value of the intercept *C* should be equal to half the width *w* of the load P. State whether the results support the suggestion. Justify your answer by reference to the results.

statement ....

justification ....

.... [2]

(g) Suggest **one** practical reason why it is difficult to obtain accurate values for *a* and for *b*.

....

.... [1]

[Total: 12]

09. 0625_s19_qp_63 Q: 1

Some students are determining the mass of a block U by a balancing method.

They are using the apparatus shown in Fig. 1.1.

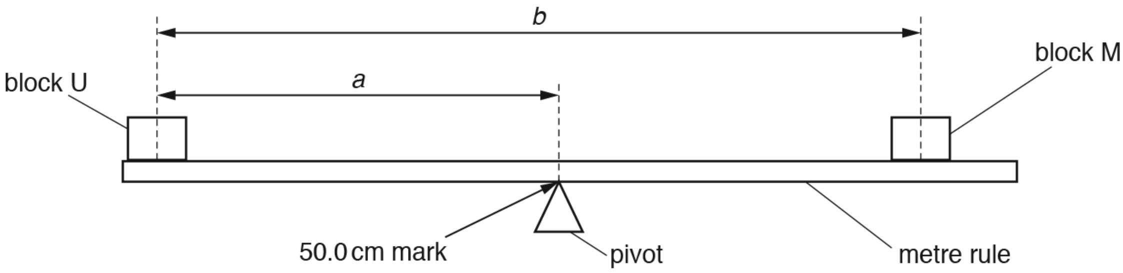


Fig. 1.1

(a) One student places the metre rule on the pivot at the 50.0 cm mark and then places block U with its centre at the 5.0 cm mark.
Suggest why it might be difficult to place block U accurately at the 5.0 cm mark. Explain how the student could overcome this difficulty. You may draw a diagram.

....

....

.... [1]

(b) **(i)** The student places block M on the metre rule as shown in Fig. 1.1 and adjusts the position of block M until the metre rule is as near to being balanced as possible.

Briefly describe a method to find the position at which the metre rule is as near to being balanced as possible.

....

....

....

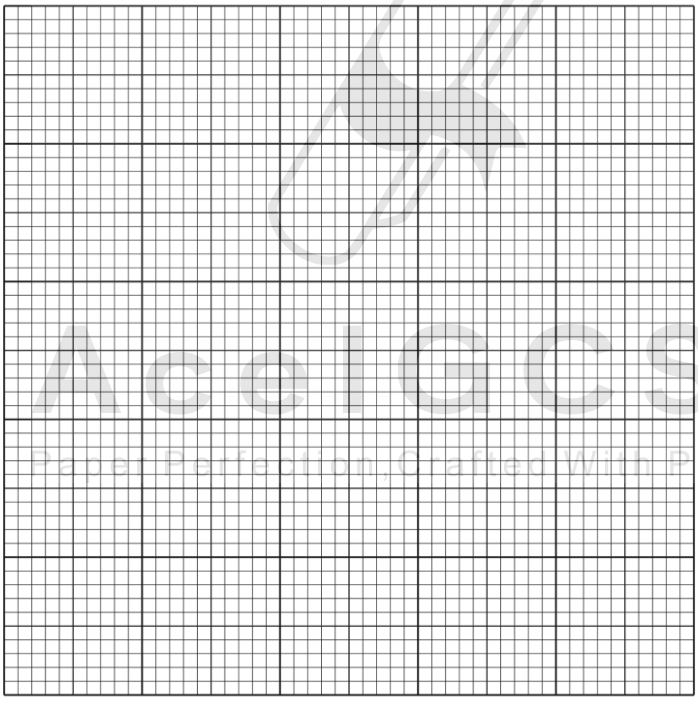
.... [1]

(ii) The student determines the distance *a* between the centre of block U and the pivot. He also determines the distance *b* between the centre of block U and the centre of block M. He repeats the procedure for positions of block U at the 10.0 cm, 15.0 cm, 20.0 cm and 25.0 cm marks.
His results are shown in Table 1.1.

Table 1.1

position of block U / cm	*a* / cm	*b* / cm
5.0	45.0	65.5
10.0	40.0	59.0
15.0	35.0	51.8
20.0	30.0	45.0
25.0	25.0	38.6

Plot a graph of *b* / cm (*y*-axis) against *a* / cm (*x*-axis). You do not need to start the axes at the origin (0,0).



[4]

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

G = ... [1]

(ii) Calculate the mass M_U of block U using the equation $M_U = (G - 1) \times k$, where $k = 200$ g.

Record the value of M_U to a suitable number of significant figures for this experiment.

M_U = ... [2]

(d) A student suggests that a and b are proportional.
State whether the results support this suggestion.
Justify your statement by reference to some results from Table 1.1.

statement ....

justification ....

....

....

[2]

[Total: 11]

10. 0625_w19_qp_61 Q: 1

A student determines the weight of a metre rule using a balancing method.

Fig. 1.1. shows the apparatus.

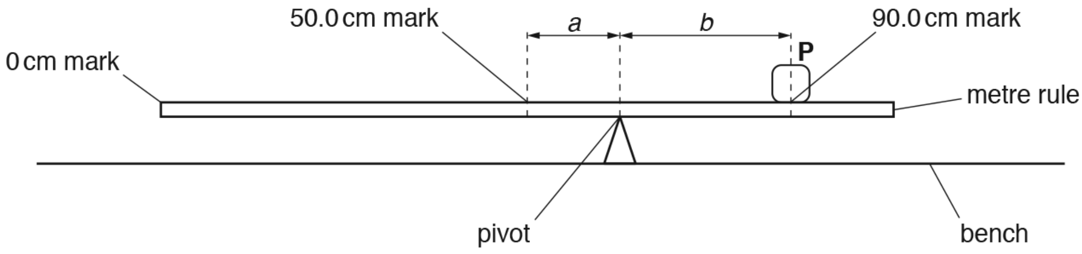


Fig. 1.1

(a) • The student places the metre rule on the pivot.

• He places the load **P**, labelled **1.5 N**, on the metre rule at the 90.0 cm mark.

• Keeping **P** at the 90.0 cm mark, he adjusts the position of the metre rule on the pivot so that the metre rule is as near as possible to being balanced.

• In Table 1.1, he records the distance *a* from the 50.0 cm mark to the pivot.

(i) Calculate, and record in Table 1.1, the distance *b* between the centre of load **P** and the pivot. [1]

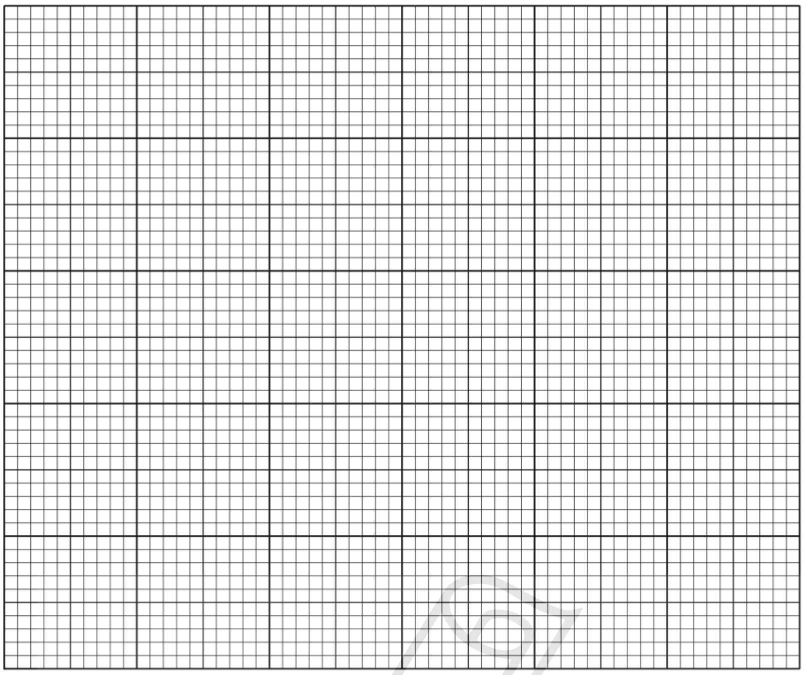
(ii) Calculate $\frac{a}{b}$. Record its value in Table 1.1. [1]

(b) The student repeats the procedure using loads of 1.2 N, 1.0 N, 0.8 N and 0.5 N. The readings and results are shown in Table 1.1.

Table 1.1

Weight of load, **P** / N	*a* / cm	*b* / cm	$\frac{a}{b}$
1.5	23.1		
1.2	21.2	18.8	1.13
1.0	18.9	21.1	0.900
0.8	16.8	23.2	0.724
0.5	12.5	27.5	0.455

Plot a graph of weight of load **P** / N (*y*-axis) against $\frac{a}{b}$ (*x*-axis). You do **not** need to begin your axes at the origin, (0,0).



[4]

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

G = ... [2]

(d) The gradient *G* is numerically equal to the weight *W* of the metre rule. Write down the value of *W* to an appropriate number of significant figures for this experiment. Include the unit.

W = ... [2]

(e) The student has assumed that the centre of mass of the metre rule is at the 50.0 cm mark. Explain briefly how you would find as accurately as possible the position of the centre of mass of the metre rule. No extra apparatus or materials are available.

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.... [1]

(f) Briefly state the main difficulty that you would have when carrying out this type of balancing experiment.

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.... [1]

[Total: 12]

11. 0625_w19_qp_61 Q: 4

A student is investigating the time taken for metal balls to stop moving after being released on a curved track. Fig. 4.1 shows the shape of the track. The track is flexible, so the shape of the curve can be changed.

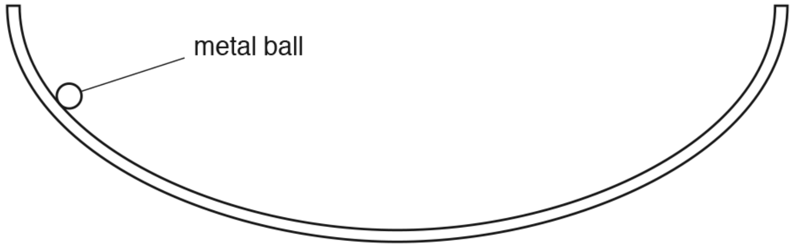

Fig. 4.1

The following apparatus is available:

a selection of metal balls of different masses
the flexible track
clamps to hold the track
a stopwatch
a tape measure
a metre rule

The student can also use other apparatus and materials that are usually available in a school laboratory.

Plan an experiment to investigate a factor that affects the time taken for metal balls to stop moving after being released on a curved track.

In your plan, you should:

- state how you would expect the balls to move
- explain how you would carry out the investigation
- state which variables you would keep constant and which variable you would change
- 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 how you would use your readings to reach a conclusion.

You may add to the diagram in Fig. 4.1 if it helps your explanation.

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[7]

[Total: 7]

12. 0625_w19_qp_63 Q: 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.

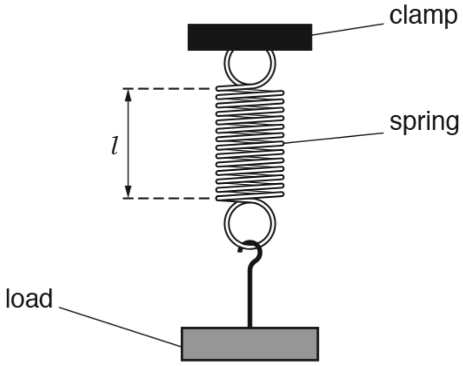

Fig. 3.1

(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.

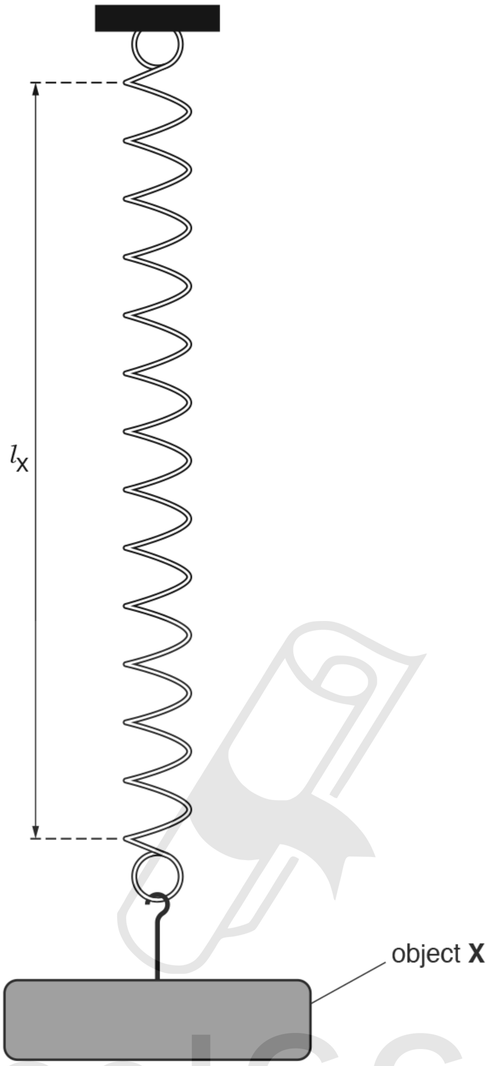

Fig. 3.2

(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]

13. 0625_m18_qp_62 Q: 1

A student is determining the mass of a metre rule by a balancing method.

He is using the apparatus shown in Fig. 1.1.

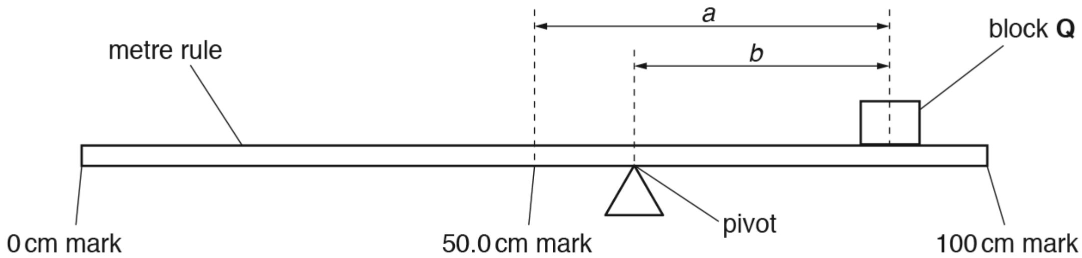

Fig. 1.1

(a) He places the metre rule on the pivot and then places block **Q** with its centre at the 95.0 cm mark.
The student stated that it is difficult to place the mass accurately at the 95.0 cm mark.

Explain how the student could overcome this. You may draw a diagram to help your explanation.

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.... [1]

(b) The student keeps block **Q** at the 95.0 cm mark and adjusts the position of the metre rule on the pivot until the metre rule is as near to being balanced as possible.

Describe a method to find the point at which the metre rule is as near to being balanced as possible.

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....[2]

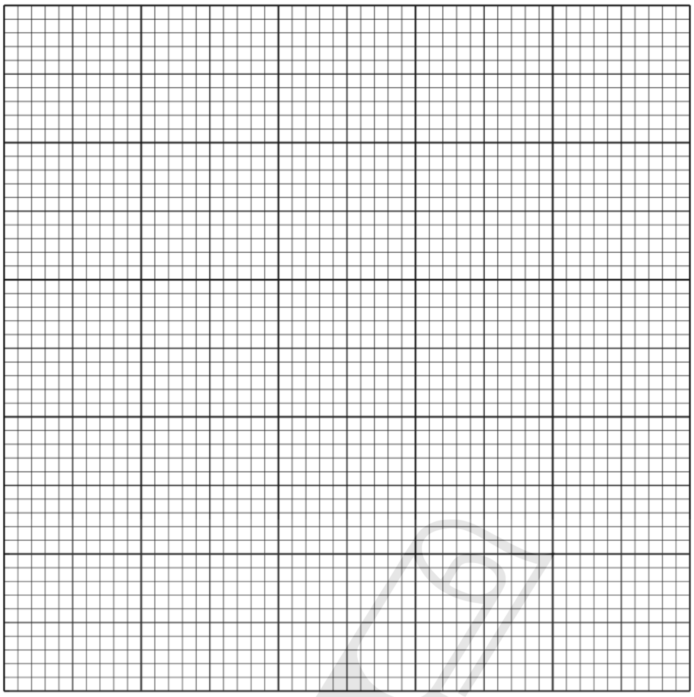
(c) The student determines the distance *a* between the centre of block **Q** and the 50.0 cm mark and also the distance *b* between the centre of block **Q** and the pivot.

He repeats the procedure for positions of block **Q** at the 90.0 cm, 85.0 cm, 80.0 cm and 75.0 cm marks. His results are shown in Table 1.1.

Table 1.1

position of **Q** / cm	*a* / cm	*b* / cm
95.0	45.0	39.0
90.0	40.0	34.3
85.0	35.0	30.0
80.0	30.0	25.2
75.0	25.0	21.4

(i) Plot a graph of a/cm (y-axis) against b/cm (x-axis). You do not need to start your axes at the origin (0, 0).



[4]

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

G = ...[1]

(iii) Calculate the mass M_R of the metre rule using the equation $M_R = \frac{M}{(G-1)}$,

where M = 20 g. Record the value for M_R to a suitable number of significant figures for this experiment.

M_R = ...[2]

(d) Two students carry out the experiment correctly but with different values for the mass of block **Q**. One student obtains values of *b* that are larger than those obtained by the other student.

State and explain whether the larger values of *b* are likely to produce a more accurate value for the mass of the metre rule.

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....[1]

[Total: 11]

14. 0625_s18_qp_62 Q: 4

A student is investigating whether the distance that a toy truck will travel along a horizontal floor, before stopping, depends on its mass.

The following apparatus is available to the student:

a ramp
blocks to support the ramp as shown in Fig. 4.1
toy truck
a selection of masses
other standard apparatus from the physics laboratory.

Plan an experiment to investigate whether the distance that the toy truck will travel along a horizontal floor, before stopping, depends on its mass.

In your plan, you should:

- explain briefly how you would carry out the investigation
- state any apparatus that you would use that is not included in the list above
- 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).

You may add to the diagram in Fig. 4.1 to help your description.

Fig. 4.1

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....[7]

[Total: 7]

15. 0625_s18_qp_63 Q: 4

A student is investigating the force needed to **just** slide a block across a surface.

Plan an experiment that will enable him to investigate how the force needed varies with the mass of the block.

The apparatus available includes:

a light, flat wooden block with a hook fitted as shown in Fig. 4.1

a pulley which can be clamped to a bench.

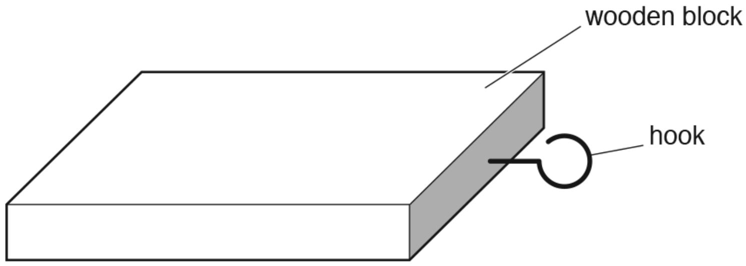

Fig. 4.1

In your plan, you should:

- list any additional apparatus needed
- draw a clearly labelled diagram of how the apparatus will be arranged
- give brief instructions for carrying out the experiment
- describe any precautions which should be taken to ensure reliable results
- suggest a graph which could be drawn.

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[Total: 7]

16. 0625_w18_qp_61 Q: 1

A student is determining the spring constant *k* of a spring by two methods.

Fig. 1.2 shows how the apparatus is used.

Method 1

(a) On Fig. 1.1, measure the unstretched length l_0 of the spring, in mm.

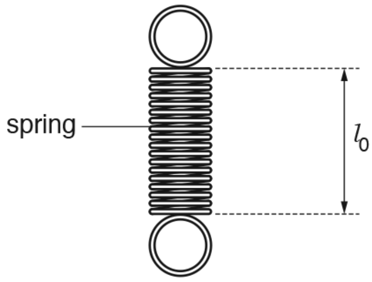

Fig. 1.1

l_0 = ... mm [1]

(b) The student attaches the spring to the clamp as shown in Fig. 1.2.

He hangs a 300 g mass on the spring.

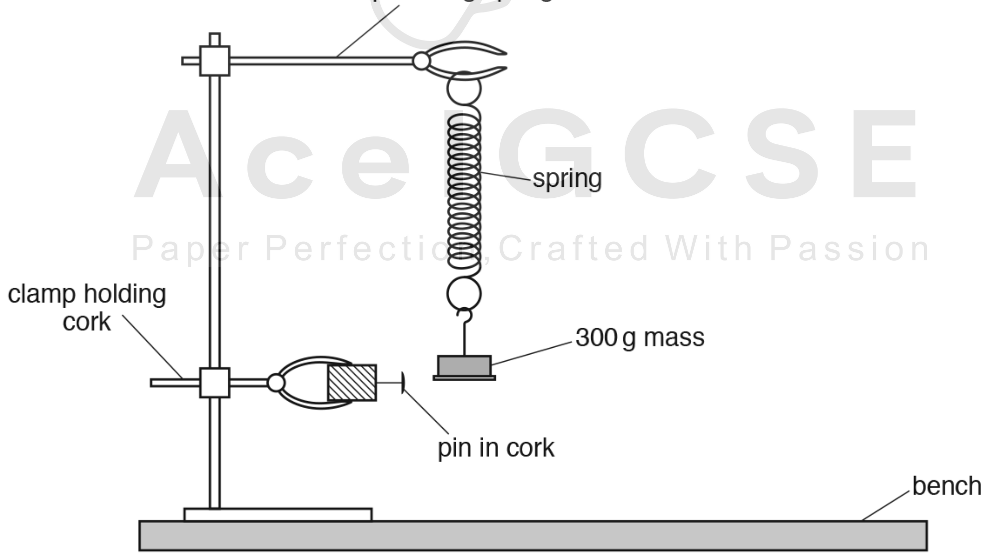

Fig. 1.2

He measures the new length *l* of the spring.

l = ...53.......................... mm

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

e = ... mm [1]

(ii) Calculate a value for the spring constant k using the equation $k = \frac{F}{e}$, where $F = 3.0\,N$.

k = ... N/mm [1]

Method 2

(c) The student pulls the mass down a short distance and releases it so that it oscillates up and down. Fig. 1.3 shows the time t taken for 10 complete oscillations.

Fig. 1.3

(i) Record the time t taken for 10 complete oscillations.

t = ... [1]

(ii) **1.** Calculate the time T taken for one complete oscillation.

T = ...

2. Calculate T^2.

T^2 = ...

[2]

(iii) Calculate the spring constant k using the equation $k = \frac{0.040\,m}{T^2}$, where $m = 0.300\,kg$.

k = ... N/mm [1]

(d) State and explain whether your two values for *k* are the same within the limits of experimental accuracy.

statement ....

explanation ....

....
[2]

(e) A student states that repeating Method 1 with different masses would improve the reliability of the value obtained for *k*.

Suggest additional values for the mass *m* that you would use when repeating the experiment to improve the reliability.

....

....

.... [2]

[Total: 11]

17. 0625_w18_qp_62 Q: 1

A student is determining the spring constant k of a spring.

Fig. 1.1 shows the apparatus used.

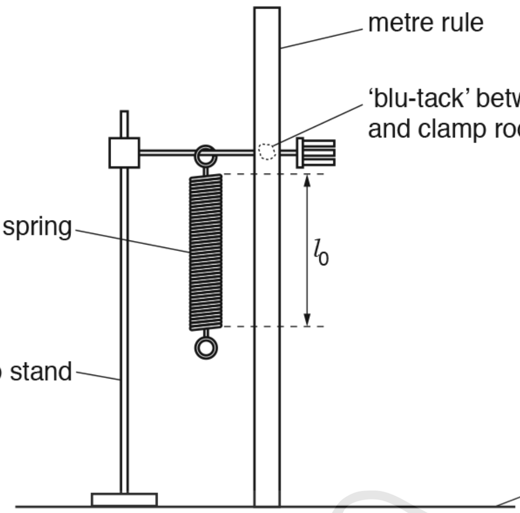

Fig. 1.1

(a) On Fig. 1.1, measure the unstretched length l_0 of the coiled part of the spring, in mm.

Record this value of length l in Table 1.1 for L = 0.00 N. [1]

(b) On Fig. 1.1, show how a set-square could be used to take readings in order to determine the length l_0 of the coiled part of the spring. [1]

(c) The student places a 0.20 N load on the spring. He records the new length l of the spring in Table 1.1.

He repeats the procedure using loads of 0.40 N, 0.60 N, 0.80 N and 1.00 N. All the readings are recorded in Table 1.1.

(i) Calculate the extension e of the spring for each value of load L, using the equation $e = (l - l_0)$. Record the values of e in Table 1.1. [1]

(ii) Complete the column headings in Table 1.1.

Table 1.1

L /	*l* /	*e* /
0.00		0
0.20	31	
0.40	40	
0.60	46	
0.80	55	
1.00	63	

[1]

(d) Plot a graph of *L* / N (*y*-axis) against *e* / mm (*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) The gradient *G* is numerically equal to the spring constant *k*.

Write down a value for *k* to a suitable number of significant figures for this experiment.

k = ... N/mm [1]

[Total: 11]

---

18. 0625_m17_qp_62 Q: 4

A student is investigating how the material of a spring affects its behaviour when stretched.

The following apparatus is available to the student:

wires of different thickness, length and material
a set of 10 g masses and a set of 100 g masses, both with hangers
a wooden rod approximately 1 cm in diameter
other standard laboratory equipment.

Plan an experiment which will enable you to test the extension of springs made from different types of wire.

In your plan, you should include:

- instructions for making a spring from the wire that is provided,
- what you will measure,
- instructions for carrying out the experiment,
- the variables you will keep the same to ensure the comparison is a fair test,
- any precaution which should be taken or difficulty which might occur,
- how you will present your results.

You may draw a diagram if it helps to explain your plan.

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....[7]

[Total: 7]

19. 0625_s17_qp_61 Q: 1

The class is investigating the stretching of a spring.

Fig. 1.1 shows the apparatus.

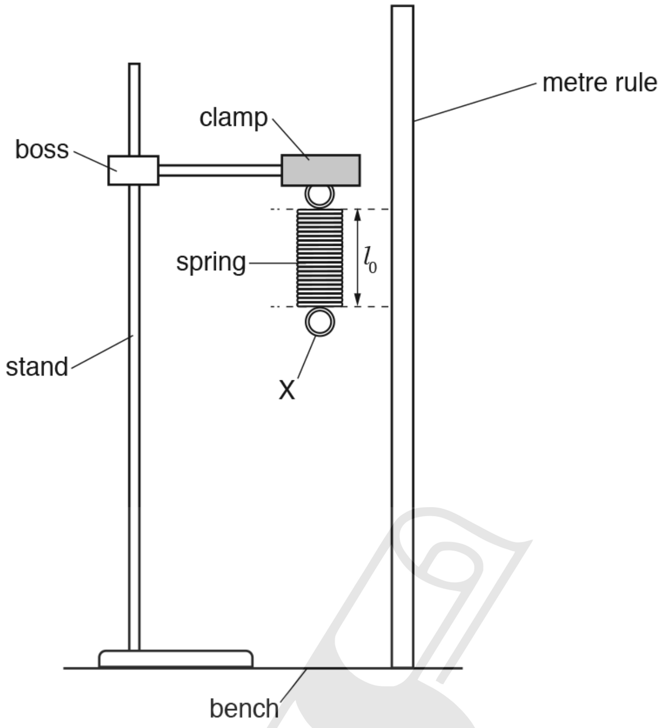


Fig. 1.1

(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.

....

....[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]

[Total: 10]

20. 0625_s17_qp_62 Q: 4

The class is investigating the principle of moments.

Fig. 4.1 shows the apparatus used.

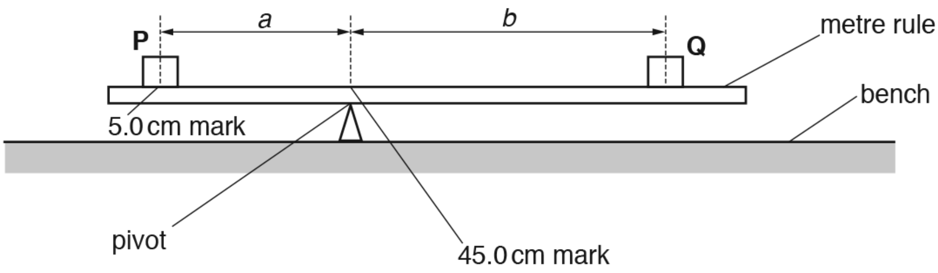


Fig. 4.1

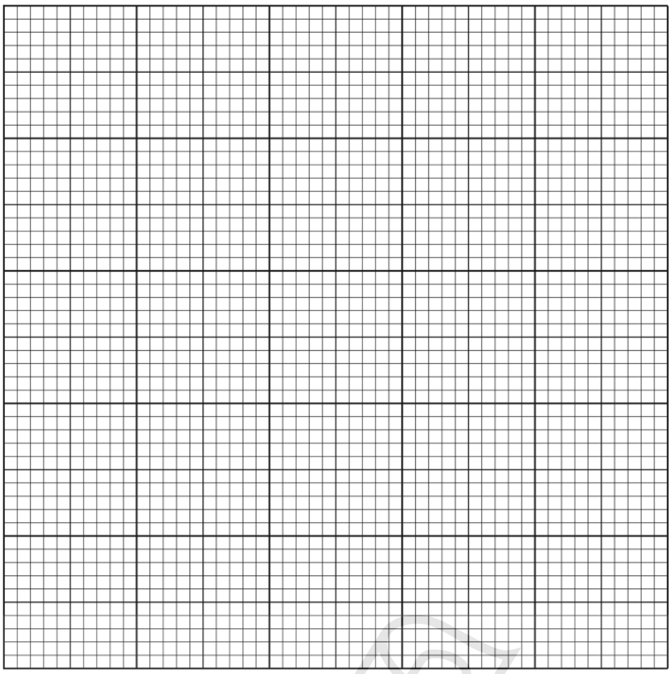
(a) A student places a load **P** on the metre rule at the 5.0 cm mark. He places the metre rule on the pivot at the 45.0 cm mark. He places a load **Q** on the rule and adjusts its position so that the metre rule is as near as possible to being balanced.

- He measures the distance *a* between the centre of load **P** and the pivot.
- He measures the distance *b* from the centre of load **Q** to the pivot.
- He repeats the procedure placing the load **P** at the 10.0 cm mark, the 15.0 cm mark, the 20.0 cm mark and at the 25.0 cm mark. He keeps the pivot at the 45.0 cm mark each time. The readings are recorded in Table 4.1.

Table 4.1

a / cm	*b* / cm
40.0	42.5
35.0	36.4
30.0	30.1
25.0	23.9
20.0	17.5

(i) Plot a graph of b/cm (y-axis) against a/cm (x-axis). Start both axes at the origin (0,0).



[3]

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

(b) A student suggests that a is directly proportional to b.

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

....

....

....[1]

(c) The student uses a balance to measure the mass m of the metre rule.

m = ...120 g..........

- Calculate the value of mX, where $X = 0.05\,\text{N cm/g}$.

mX = ... N cm

- Use the value of a in the first row of Table 4.1 to calculate Pa, where $P = 1.00\,\text{N}$. P is the weight of load **P**. Include the unit.

Pa = ...

- Use the value of b in the first row of Table 4.1 to calculate Qb, where $Q = 0.80\,\text{N}$. Q is the weight of load **Q**.

Qb = ...

[2]

(d) A student states that Pa should be equal to Qb.

Look carefully at Fig. 4.1 and the information in **(c)** and suggest what the student has not realised.

....

....[1]

[Total: 8]

21. 0625_w17_qp_61 Q: 4

A student is determining the weight of a load using a balancing method.

Fig. 4.1 shows the apparatus used.

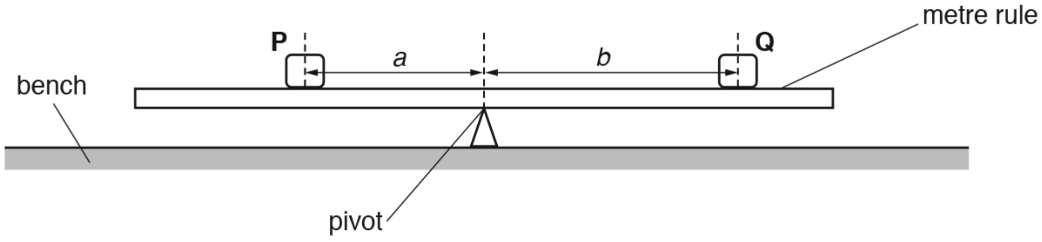


Fig. 4.1

The student places the metre rule on the pivot and adjusts its position so that the metre rule is as near as possible to being balanced.

He places a load **P** on the metre rule so that its centre is exactly at the 30.0 cm mark.

He records the distance *a* between **P** and the pivot.

a = ...19.8 cm....................

He places a load **Q** of weight *Q* = 1.0 N on the metre rule and adjusts the position of **Q** so that the metre rule is as near as possible to being balanced.

He measures the distance *b* between the centre of load **Q** and the pivot.

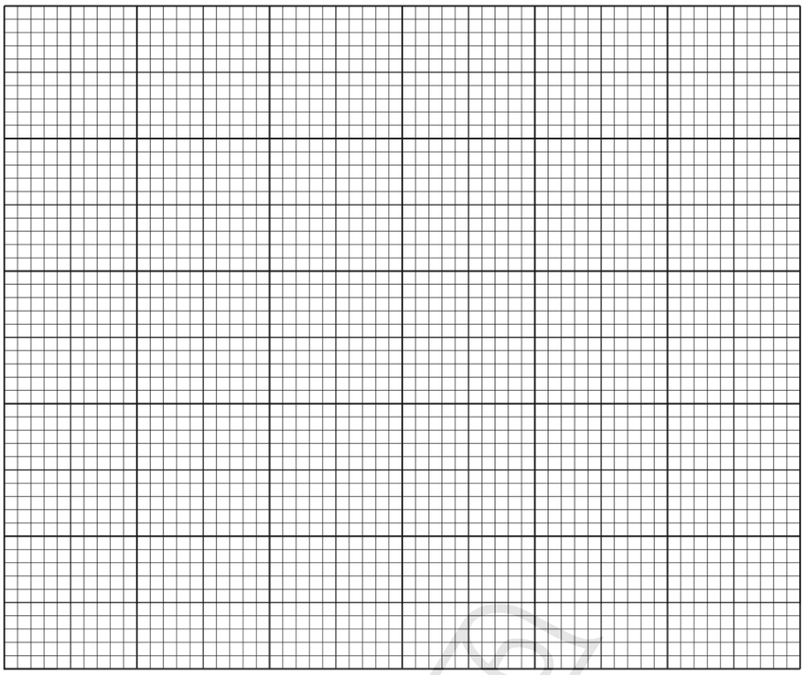
He repeats the procedure, with the load **P** remaining at the 30.0 cm mark, using *Q* values of 2.0 N, 3.0 N, 4.0 N and 5.0 N. All the readings are recorded in Table 4.1.

Table 4.1

Q/N	b/cm	$\frac{1}{Q}\Big/\frac{1}{N}$
1.0	40.0	
2.0	19.5	
3.0	13.5	
4.0	10.5	
5.0	7.5	

(a) For each value of *Q*, calculate $\frac{1}{Q}$ and record the result in the table. [1]

(b) Plot a graph of b/cm (y-axis) against $\frac{1}{Q}\Big/\frac{1}{N}$ (x-axis).



[4]

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

G = ... [2]

(ii) Calculate the weight P of load **P** using the equation $P = \frac{G}{a}$, where a = 19.8 cm.

P = ... [1]

(d) The student measures the weight *P* of load **P** using a forcemeter. Fig. 4.2 shows the forcemeter.

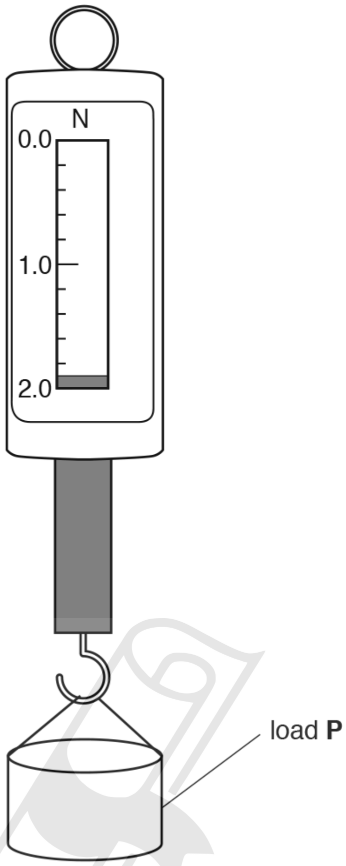


Fig. 4.2

Write down the reading *P* shown on the forcemeter.

P = ... N [1]

(e) The student has carried out the experiment with care and is expecting the two values of *P* in **(c)** and **(d)** to be the same.

Suggest **two** reasons why the values of *P* may be different.

1. ....

....

2. ....

....

[2]

[Total: 11]

22. 0625_w17_qp_62 Q: 4

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.

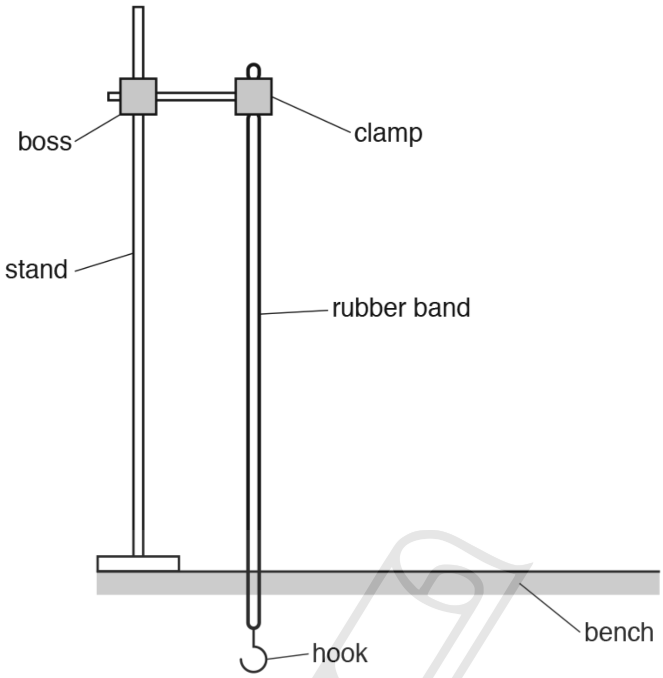


Fig. 4.1

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]

23. 0625_w17_qp_63 Q: 3

Some students are determining the weight of a metre rule.
They use the apparatus shown in Fig. 3.1.

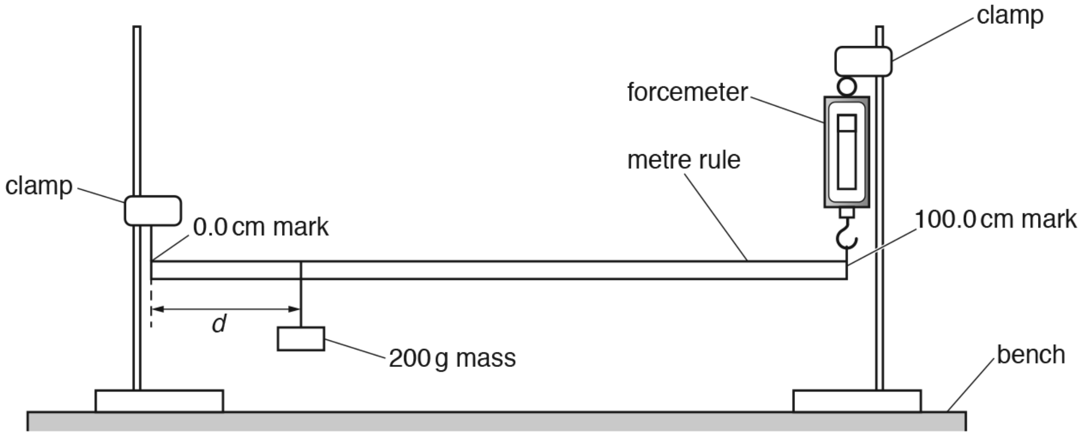

Fig. 3.1

(a) (i) The students suspend a 200 g mass at a distance *d* from the end of the rule.
They then adjust the height of the clamp holding the forcemeter so that the rule is horizontal.

Fig. 3.2 shows the forcemeter when the value of *d* is 10.0 cm.

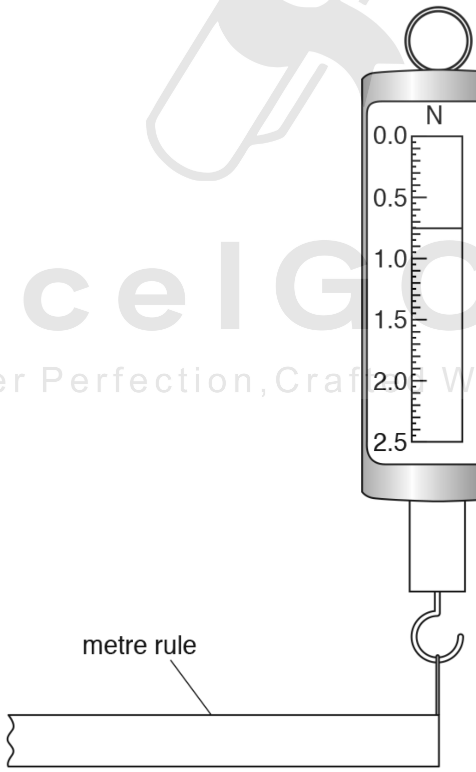

Fig. 3.2

In Table 3.1, record the forcemeter reading *F*, as shown in Fig. 3.2. [1]

Table 3.1

d / cm	*F* / N
10.0	
30.0	1.05
50.0	1.65
70.0	1.95
90.0	2.25

(ii) The students repeat the procedure for values of *d* = 30.0 cm, 50.0 cm, 70.0 cm and 90.0 cm. Their readings are shown in Table 3.1.

Explain how the students could make sure that the rule is horizontal before each reading. You may draw a diagram.

....

....

....[1]

(b) Plot a graph of F/N (y-axis) against d/cm (x-axis).
Start your axes from the origin (0, 0).

Draw a best-fit line.

[4]

(c) **(i)** From your graph, determine F_0, the value of F when d = 0.0 cm.

F_0 = ...[1]

(ii) Calculate the weight W_R of the metre rule, using the equation $W_R = 2 \times F_0$.
Give W_R to a suitable number of significant figures for this experiment.

W_R = ...[2]

(d) A student correctly plots your data points on another sheet of graph paper.

State and explain whether his best-fit line is likely to be the same as yours.
Justify your answer with reference to the plots.

statement ....

explanation ....

....

....
[1]

(e) Another student, carrying out the same experiment, is not sure if some of his values of *F* are correct.

Suggest **one** improvement to the procedure which would help him to obtain more reliable *F* values.

....

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....[1]

[Total: 11]

24. 0625_p16_qp_60 Q: 1

A student is determining the mass of a load using a balancing method.

Fig. 1.1 shows the apparatus.

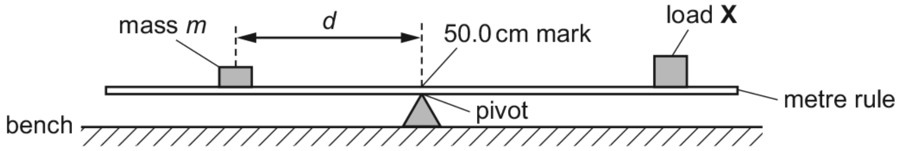

Fig. 1.1

The load **X** has been taped to the metre rule so that its centre is exactly over the 90.0 cm mark. It is not moved during the experiment.

A mass *m* of 40 g is placed on the rule and its position adjusted so that the rule is as near as possible to being balanced with the 50.0 cm mark exactly over the pivot. Fig. 1.2(a) shows part of the rule when it is balanced.

The procedure is repeated for a range of masses. Fig. 1.2(b)–(e) shows the rule when balanced for values of *m* of 50 g, 60 g, 70 g and 80 g.

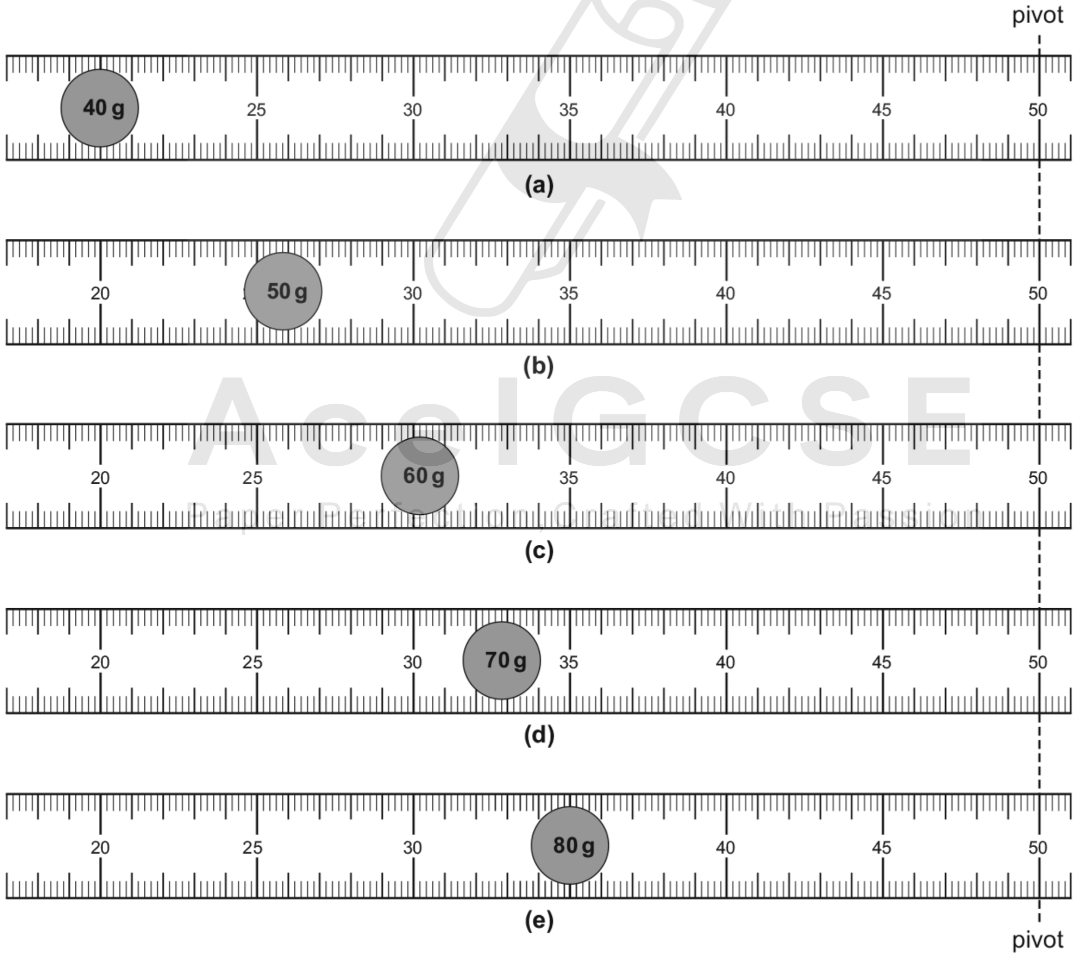

Fig. 1.2

(a) **(i)** Use Fig. 1.2 to determine *d*, the distance between the mass and the pivot at balance, for each value of *m*. Record your results in Table 1.1. [3]

Table 1.1

m / g	d / cm	$\frac{1}{d} / \frac{1}{\text{cm}}$
40		
50		
60		
70		
80		

(ii) For each value of *d*, calculate 1 / *d* and record it in the table. [1]

(b) Describe one difficulty the student might have when carrying out this experiment, and how he might overcome this difficulty.

....

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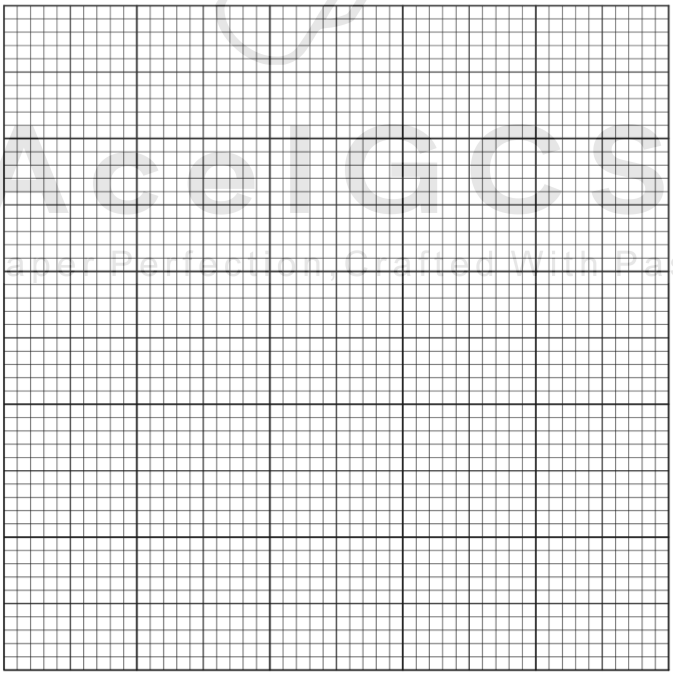
.... [2]

(c) Plot a graph of m / g (y-axis) against $\frac{1}{d} / \frac{1}{\text{cm}}$ (x-axis).



[4]

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

G = ... [1]

(e) Determine the mass μ, in grams, of the load **X**. Use the equation $\mu = \frac{G}{40.0}$.

μ = ... g [1]

[Total: 12]

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25. 0625_p16_qp_60 Q: 4

A student's plastic bottle of water tips over in class.

Plan an experiment to investigate how the quantity of water in a plastic bottle affects its stability.

The plastic bottle holds up to 2000 cm^3 of water and has a height of 42 cm.

(a) Write a plan for the experiment, including:

- the apparatus needed
- instructions for carrying out the experiment
- the values you will use for the quantity of water
- how you will make sure your results are as accurate as possible
- the graph you will plot from your results

A diagram is not required, but you may add to Fig. 4.1, or draw your own diagram, if it helps to explain your plan.

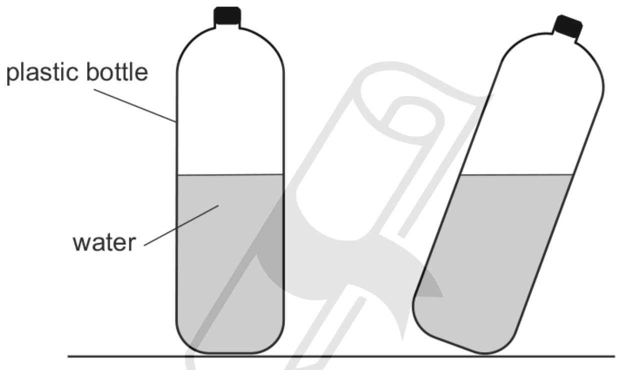

Fig. 4.1

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....[7]

(b) On Fig. 4.1, measure the angle through which the bottle has been tilted.

angle = ... [1]

[Total: 8]

---

26. 0625_s16_qp_61 Q: 1

A student is determining the weight of a metre rule using a balancing method.

The apparatus is shown in Fig. 1.1.

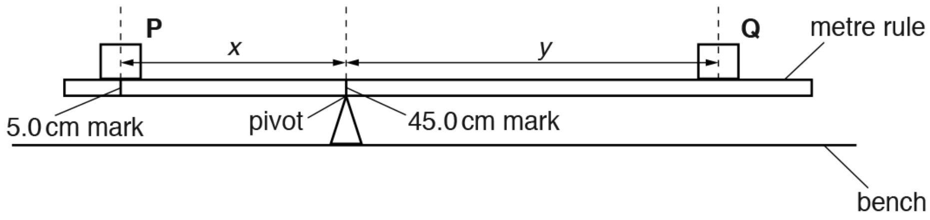


Fig. 1.1 (not to scale)

(a) • The student places the load **P** on the metre rule at the 5.0 cm mark.

- She places the metre rule on the pivot at the 45.0 cm mark.
- She places load **Q** on the rule and adjusts its position so that the metre rule is as near as possible to being balanced.
- She measures the distance *x* between the centre of load **P** and the pivot and the distance *y* from the centre of load **Q** to the pivot.
- She repeats the procedure, placing the load **P** at the 10.0 cm mark, at the 15.0 cm mark, at the 20.0 cm mark and at the 25.0 cm mark. The readings are shown in Table 1.1.

Table 1.1

x /	*y* /	*A* /	*B* /
40.0	42.5		
35.0	36.0		
30.0	30.0		
25.0	24.0		
20.0	17.5		

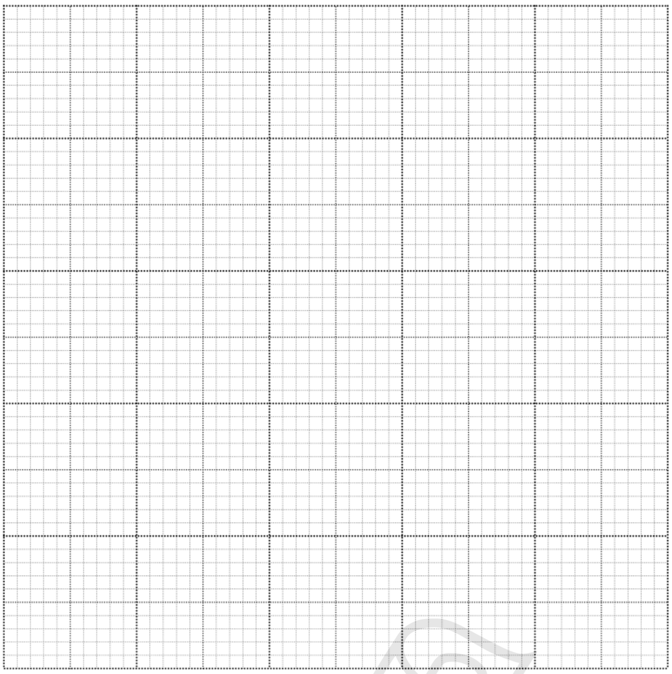
(i) • For each value of *x*, calculate $A = Px$, where $P = 1.00$ N. Record the values in the table. *P* is the weight of load **P**.

- For each value of *y*, calculate $B = Qy$, where $Q = 0.80$ N. Record the values in the table. *Q* is the weight of load **Q**.

[1]

(ii) Complete the column headings in the table. [1]

(b) Plot a graph of A/Ncm (y-axis) against B/Ncm (x-axis). Start both axes at the origin (0,0).



[4]

(c) Using the graph, determine the vertical intercept Y (the value of A when B = 0Ncm). Show clearly on the graph how you obtained this value.

Y = ... [1]

(d) Calculate the weight W of the metre rule using the equation $W = \frac{Y}{z}$, where z = 5.0cm.

W = ... [1]

(e) Suggest one practical reason why it is difficult to obtain exact results with this experiment.

....

.... [1]

(f) The student uses an accurate electronic balance to obtain a second value for the weight of the metre rule.

weight obtained on the balance = ...1.24 N..........

State and explain whether the two values for the weight agree within the limits of experimental accuracy.

statement ....

justification ....

....

[1]

[Total: 10]

27. 0625_s16_qp_62 Q: 1

A student is investigating the stretching of a spring.

The apparatus is shown in Fig. 1.1.

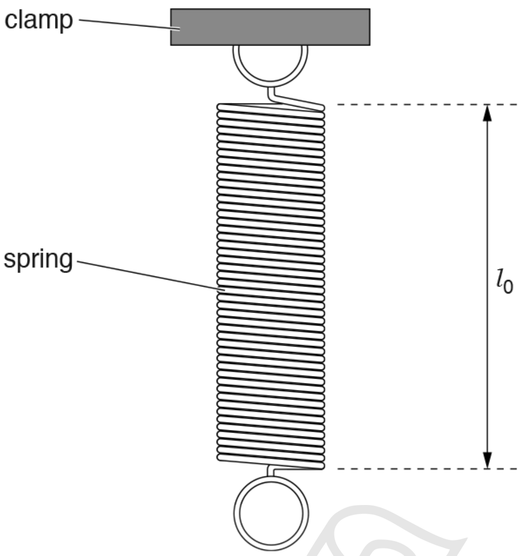


Fig. 1.1

(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	

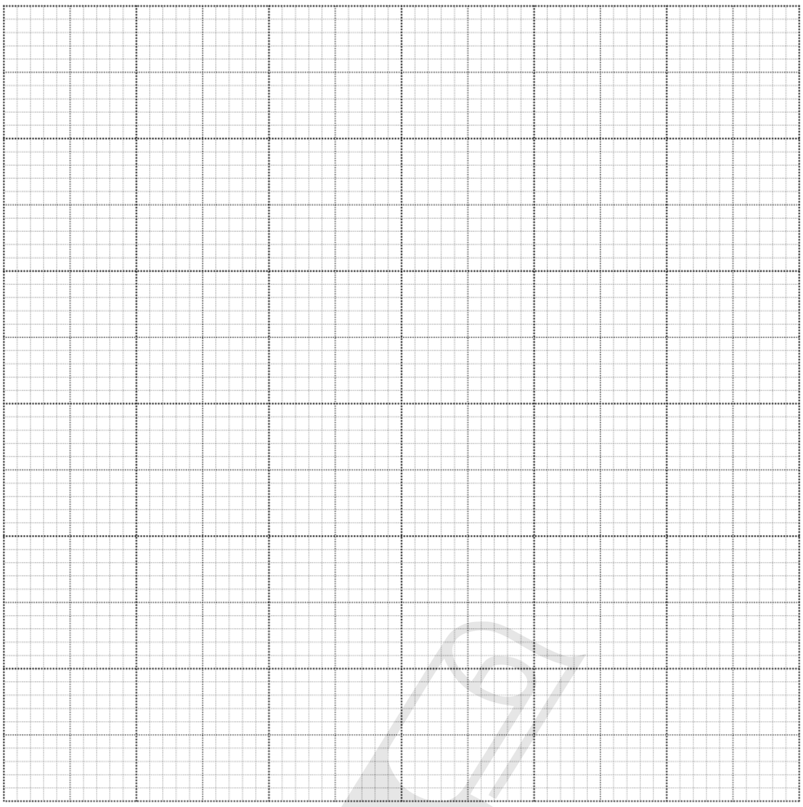
[1]

(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]

28. 0625_s16_qp_62 Q: 2

A student is using a balancing method to determine the weight of a piece of soft modelling clay. The apparatus is shown in Fig. 2.1.

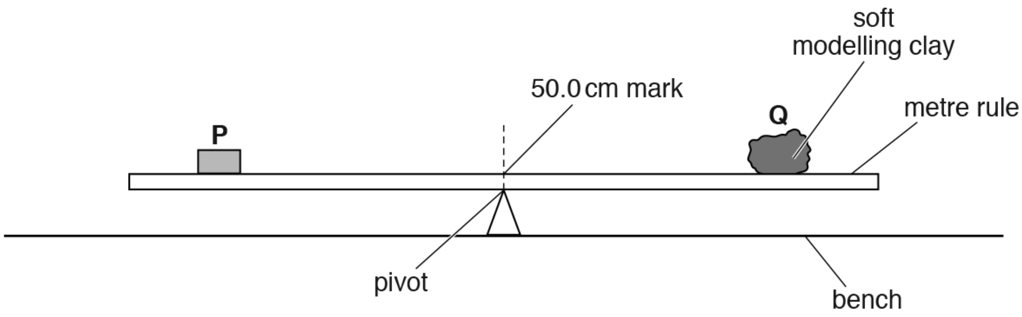


Fig. 2.1

P is a metal cube of weight $P = 1.0\,\text{N}$. **Q** is the piece of soft modelling clay.

The student places the cube **P** so that its weight acts at a distance x from the pivot.

He adjusts the position of **Q** to balance the rule and measures the distance y from the centre of **Q** to the pivot. He calculates the weight W of **Q** using the equation $W = \frac{Px}{y}$.

(a) **On Fig. 2.1**, mark clearly the distance x. [1]

(b) Suggest a change to **Q** that would make it easier to find the value of y accurately.

....

....[1]

(c) It is difficult to achieve an exact balance of the metre rule in this type of experiment. This can make the result unreliable.

Explain how you would reduce the effect of this problem to improve the reliability of the experiment.

....

....

....[1]

(d) The metal cube **P** is larger than the width of the metre rule.

Explain briefly how you would determine the reading of the metre rule scale at the position of the centre of mass of **P**. You may draw a diagram.

....

....

....[2]

(e) Before starting the experiment, the student determines the position of the centre of mass of the metre rule.

Explain briefly how you would do this.

....

....[1]

[Total: 6]

29. 0625_s16_qp_63 Q: 2

A student is using a forcemeter and a set of different loads to determine the weight of a metre rule.

She is using the apparatus shown in Fig. 2.1.

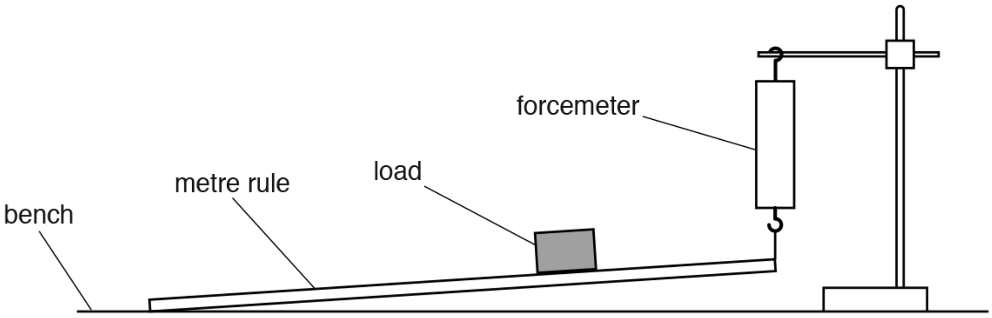


Fig. 2.1

(a) Fig. 2.2 shows the position of the load on the metre rule. The load is always at this position on the rule.

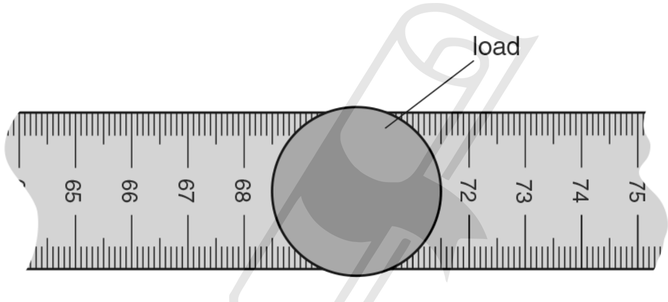


Fig. 2.2 (not full size)

Determine the scale reading on the metre rule at which the centre of the load is located. Show your working.

scale reading = ... cm [2]

(b) The student measures the force F indicated by the forcemeter for different loads placed on the rule.

Figs. 2.3 (a)–(e) show the scale of the forcemeter for values of load L = 1.00 N, 2.00 N, 3.00 N, 4.00 N and 5.00 N.

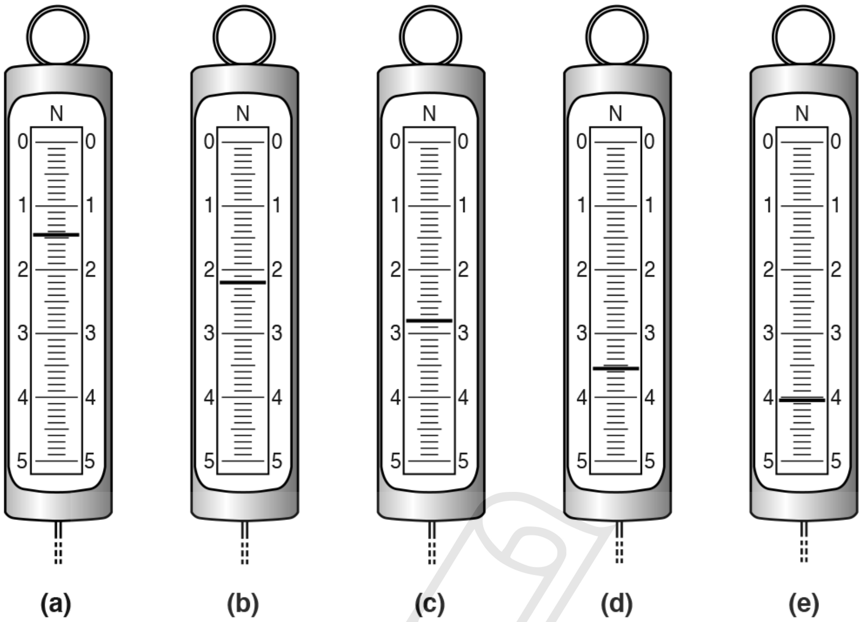


Fig. 2.3

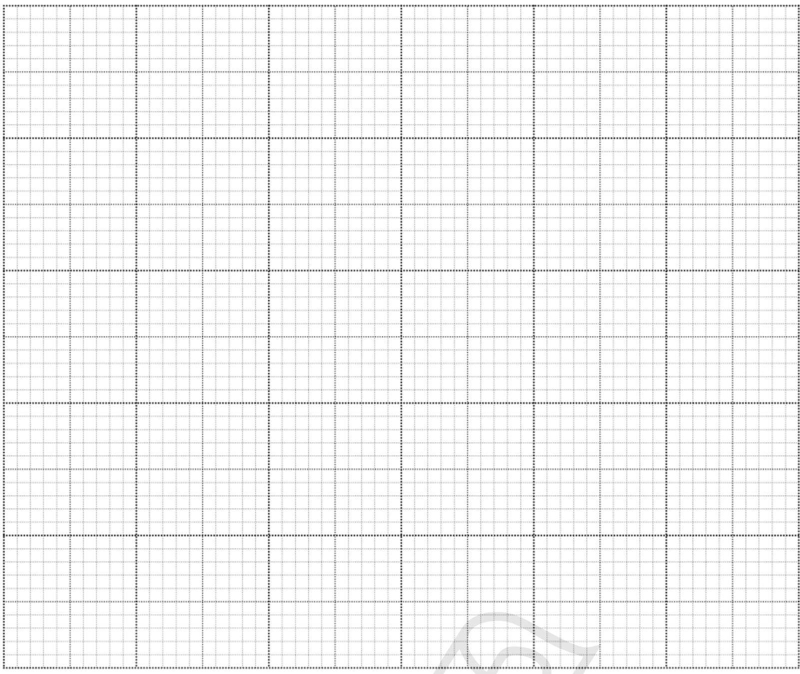
In Table 2.1, record the value of F for each load.

Table 2.1

L / N	F / N
1.00	
2.00	
3.00	
4.00	
5.00	

[2]

(c) Plot a graph of F/N (y-axis) against L/N (x-axis). Start your graph at the origin (0,0).



[4]

(d) **(i)** Determine the value y of the intercept of the line on the F axis.

y = ...[1]

(ii) The weight W of the metre rule is numerically equal to $2y$.

Write down a value for W to a suitable number of significant figures for this experiment.

W = ...[2]

(e) Assuming that the procedure is carried out carefully, suggest a possible source of inaccuracy in this experiment.

....

....

....[1]

[Total: 12]

30. 0625_w16_qp_61 Q: 5

A student is investigating the extension of a spring.

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

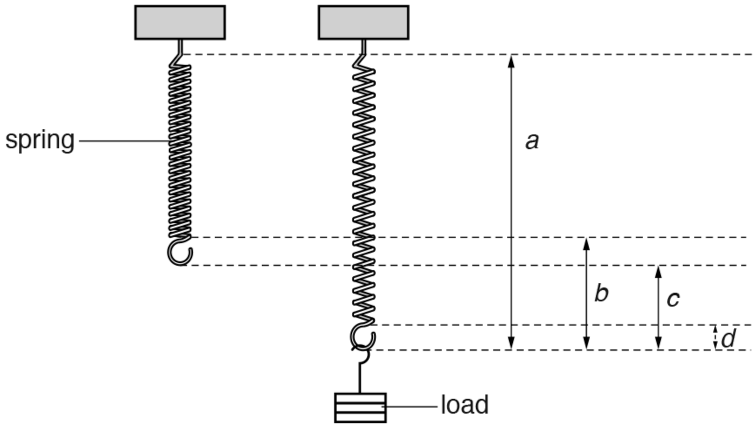


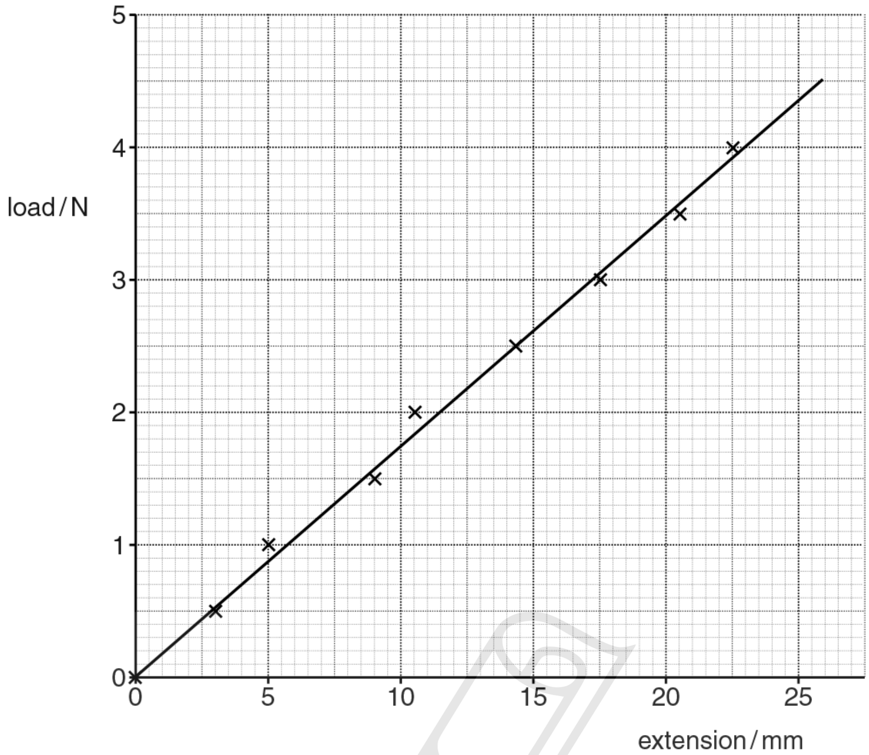
Fig. 5.1

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]

31. 0625_w16_qp_62 Q: 1

A student is determining the weight of a load using a balancing method.

Fig. 1.1 shows the apparatus. It is not drawn to scale.

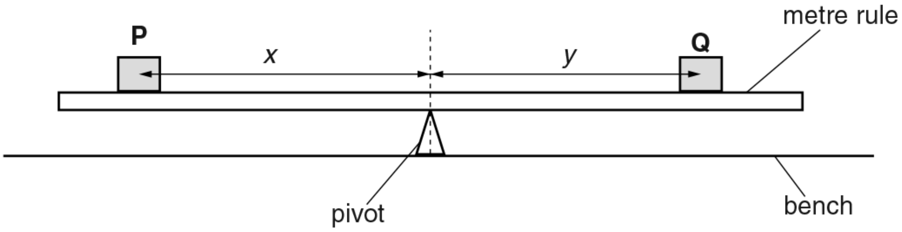


Fig. 1.1 (not to scale)

(a) The student places the metre rule on the pivot and adjusts its position so that the metre rule is as near as possible to being balanced. He records the scale reading of the metre rule at the point where the rule balances on the pivot.

scale reading = ...50.2 cm..........

He places a 2.00 N load **P** on the metre rule so that its centre is exactly at the 20.0 cm mark on the rule.

(i) Use this information to determine the distance *x*.

x = ... cm [1]

(ii) Explain how you would ensure that the centre of the load **P** is exactly at the 20.0 cm mark on the rule. You may draw a diagram.

(b) The student places a load **Q** on the metre rule and adjusts its position so that the metre rule is as near as possible to being balanced.

He measures the distance y between the centre of load **Q** and the pivot.

y = ...15.3 cm..................

Calculate the weight W of load **Q** using the equation $W = \frac{kx}{y}$, where k = 2.00 N.

W = ...[1]

(c) The student repeats the procedure using a different, suitably chosen, distance x.

Suggest a suitable distance x.

x = ...cm [1]

(d) The student calculates a new value of W.

W = ...4.04 N..................

Suggest two reasons why the values determined for W may not be the same.

1. ....

2. ....

[2]

(e) Calculate the average W_{AV} of the values for W, the weight of load **Q**. Give your answer to a suitable number of significant figures for this experiment.

W_{AV} = ...N [2]

[Total: 9]

32. 0625_w16_qp_63 Q: 4

A student has noticed that different types of paper have different strengths.

Plan an experiment which will enable you to compare the strengths of different samples of thin paper, prepared as shown in Fig. 4.1.

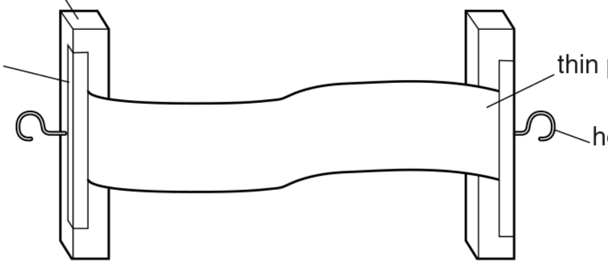


Fig. 4.1

Write a plan for the experiment, including:

- the additional apparatus needed
- instructions for carrying out the experiment, including any precautions you will take
- what you will measure
- how you will present your results
- how you will determine which paper is the strongest
- the variables you will keep the same to ensure the comparison is a fair test.

You may draw a diagram if it helps to explain your plan.

....
....
....
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....
....
....
....
....
....
.... [7]

[Total: 7]

33. 0625_m15_qp_62 Q: 1

A student is determining the mass of a metre rule by a balancing method.

He is using the apparatus shown in Fig. 1.1.

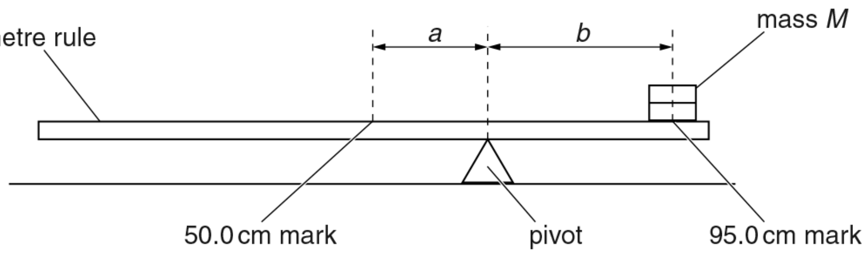


Fig. 1.1

(a) He places the metre rule on the pivot and then places a mass M = 20 g with its centre at the 95.0 cm mark.

Suggest how he could ensure that the mass is placed accurately at the 95.0 cm mark. You may draw a diagram.

....

....

....[1]

(b) Keeping the mass at the 95.0 cm mark, he adjusts the position of the metre rule on the pivot until the metre rule is as near to being balanced as possible.

The student then determines the distance a between the 50.0 cm mark and the pivot and the distance b between the 95.0 cm mark and the pivot.

He repeats the procedure for values of M = 40 g, 60 g, 80 g and 100 g. His results are shown in Table 1.1.

Table 1.1

M / g	a / cm	b / cm	S
20	6.5	38.5	
40	11.2	33.8	
60	15.2	29.8	
80	17.1	27.9	
100	20.0	25.0	

For each value of M, calculate and record in the table the value S, where $S = \frac{a}{b}$. [1]

(c) Plot a graph of *S* (*y*-axis) against *M* / g (*x*-axis).

[4]

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

G = ...[1]

(ii) The mass M_R of the metre rule is numerically equal to $\frac{1}{G}$.

Write down a value for M_R to a suitable number of significant figures for this experiment.

M_R = ...g [1]

(e) Determination of M_R by this method relies on the centre of mass of the rule being at the 50.0 cm mark.

Suggest how you could use the apparatus to test whether this is the case. You may draw a diagram.

....

....

....[1]

[Total: 9]

34. 0625_s15_qp_61 Q: 1

The class is determining the weight of a metre rule using a balancing method.

The apparatus is shown in Fig. 1.1.

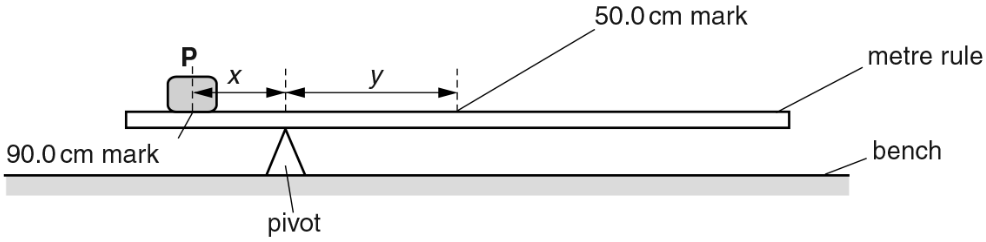


Fig. 1.1

(a) A student places a load **P** at the 90.0 cm mark on a metre rule and then balances the rule on a pivot.

(i) On Fig. 1.1, measure the distance *x* from the 90.0 cm mark to the pivot.

x = ...[1]

(ii) On Fig. 1.1, measure the distance *y* from the pivot to the centre of the rule.

y = ...[1]

(b) Fig. 1.1 is drawn one tenth of actual size.

(i) Calculate the actual distance *X* from the 90.0 cm mark to the pivot.

X = ...

(ii) Calculate the actual distance *Y* from the pivot to the centre of the rule.

Y = ...
[1]

(iii) Determine a value W_1 for the weight of the metre rule using the equation $W_1 = \frac{PX}{Y}$, where $P = 2.0\,\text{N}$. *P* is the weight of the load **P**.

W_1 = ...[1]

(c) The student keeps the pivot at the same position and moves load **P** to the 95.0 cm mark. He places a load **Q** of weight $Q = 1.0\,N$, on the metre rule. He adjusts its position so that the rule balances.

On Fig. 1.2 mark, with a letter Z, the approximate position of the load **Q**. You do not need to carry out a detailed calculation.

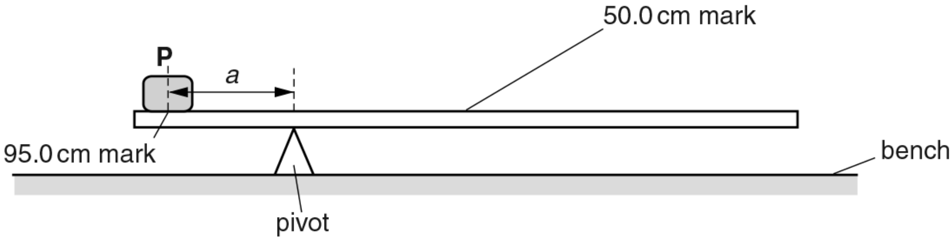


Fig. 1.2

[1]

(d) The student uses the values of **P** and **Q** and their distances from the pivot to calculate a second value W_2 for the weight of the rule.

W_2 = ... 1.12 N ....

The student expects W_1 and W_2 to be the same.

State whether the results support his idea. Justify your answer by reference to the results.

statement ....

justification ....

....

....

[2]

(e) Suggest one practical reason why it is difficult to obtain exact results with this experiment.

....

....[1]

[Total: 8]

35. 0625_s15_qp_63 Q: 1

The class is determining the mass of an object using two strings.

The apparatus is set up as shown in Fig. 1.1.

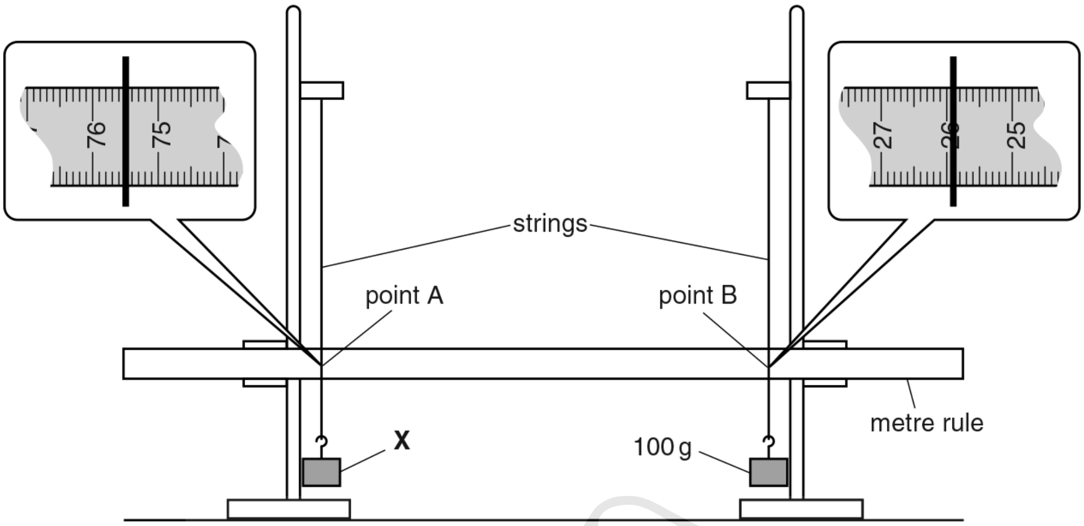


Fig. 1.1

(a) **(i)** Record the scale reading a_0 at point A, where the string crosses the rule, as indicated in the enlarged section of Fig. 1.1.

a_0 = ...

(ii) Record the scale reading b_0 at point B.

b_0 = ...

[2]

(b) A loop of string is placed around the vertical strings so that they are pulled closer together, as shown in Fig. 1.2. The loop is horizontal and is just above the rule.

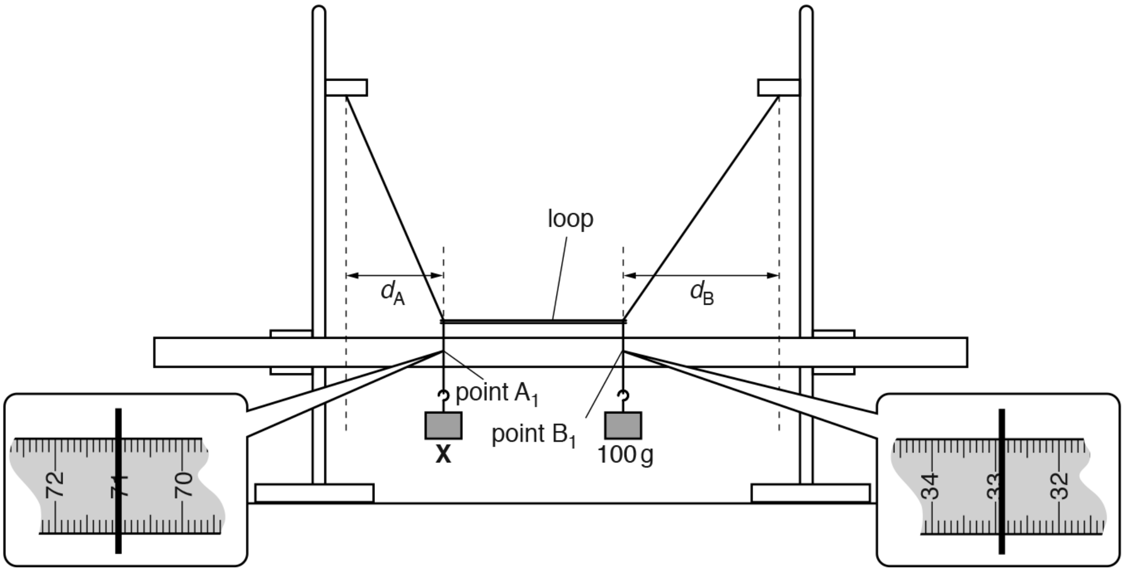


Fig. 1.2

(i) Record the scale reading a_1 at point A_1 as indicated in the enlarged section of Fig. 1.2.

a_1 = ...

(ii) Record the scale reading b_1 at point B_1.

b_1 = ...
[1]

(iii) Calculate and record the distance d_A, shown in Fig. 1.2. Use your results from **(a)(i)** and **(b)(i)**. d_A is the difference between a_0 and a_1.

d_A = ...

(iv) Calculate and record the distance d_B. Use your results from **(a)(ii)** and **(b)(ii)**. d_B is the difference between b_1 and b_0.

d_B = ...
[1]

(c) Calculate the mass M of object **X**, using your results from **(b)(iii)** and **(b)(iv)** and the equation $M = \frac{k\,d_B}{d_A}$ where $k = 100\,g$.

M = ...[2]

(d) Explain how you could ensure that the loop is horizontal in **(b)**. You may draw a diagram.

....

....

....[1]

(e) A student suggests that d_A and d_B might be directly proportional to each other.

Briefly describe how this experiment could be extended to investigate the suggestion.

....

....

....[2]

[Total: 9]

36. 0625_w15_qp_62 Q: 1

The class is investigating the masses of two loads, **P** and **Q**.

Fig. 1.1 shows the apparatus.

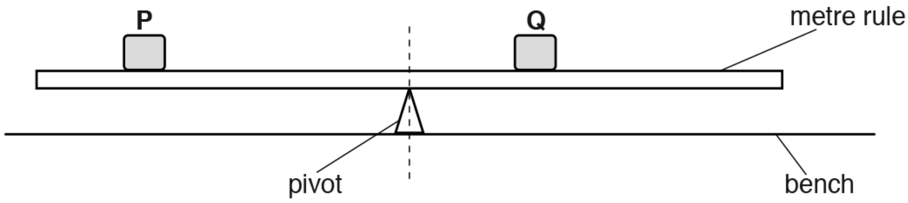


Fig. 1.1

(a) A student places the metre rule on the pivot at the 50.0 cm mark.

He places the load **P** on the metre rule. He then places the load **Q** on the metre rule and adjusts its position so that the metre rule is as near as possible to being balanced.

(i) On Fig. 1.1, measure the distance *x* from the centre of load **P** to the pivot.

x = ...

(ii) On Fig. 1.1, measure the distance *y* from the pivot to the centre of load **Q**.

y = ...
[1]

(iii) Fig. 1.1 is drawn 1/10th full size.

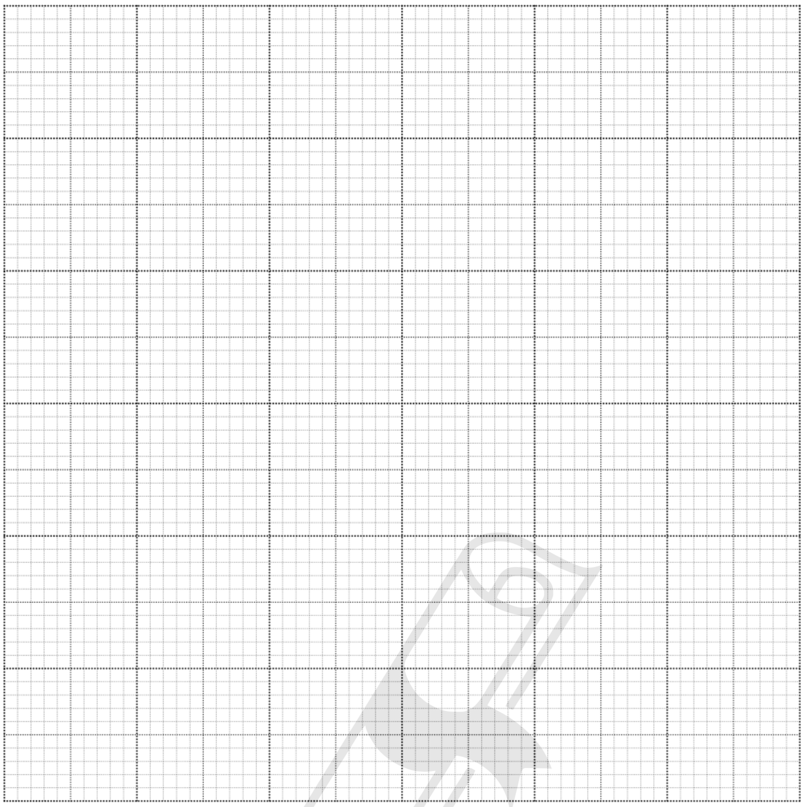
Calculate the actual distance *a* from the centre of load **P** to the pivot. Calculate the actual distance *b* from the pivot to the centre of load **Q**. Write the results in Table 1.1. [1]

Table 1.1

a / cm	*b* / cm
35.0	17.6
30.0	14.8
25.0	12.7
20.0	10.1

(b) The student repeats the procedure using different positions of **P**. His readings are shown in the table.

Plot a graph of *b*/cm (*y*-axis) against *a*/cm (*x*-axis).



[4]

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

G = ...[2]

(d) The gradient *G* is the ratio of the masses of the two loads **P** and **Q**.

Suggest a suitable value for the mass of **P** in this experiment. Use this, and your value for *G*, to determine an estimate for the mass of **Q**.

estimated mass of **P** = ...

estimated mass of **Q** = ...
[2]

[Total: 10]

37. 0625_w15_qp_63 Q: 2

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.

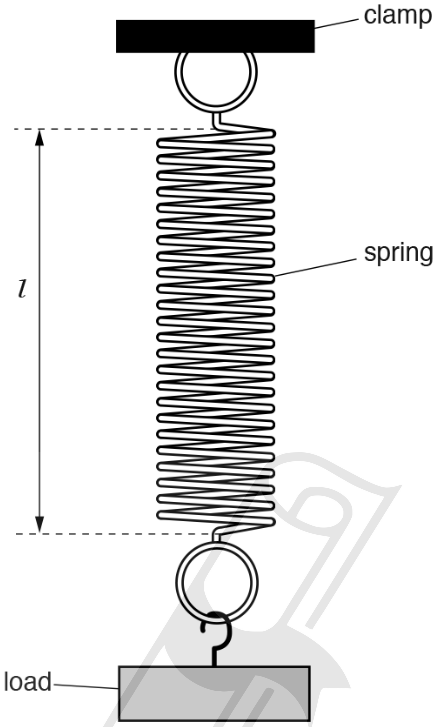


Fig. 2.1

(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.

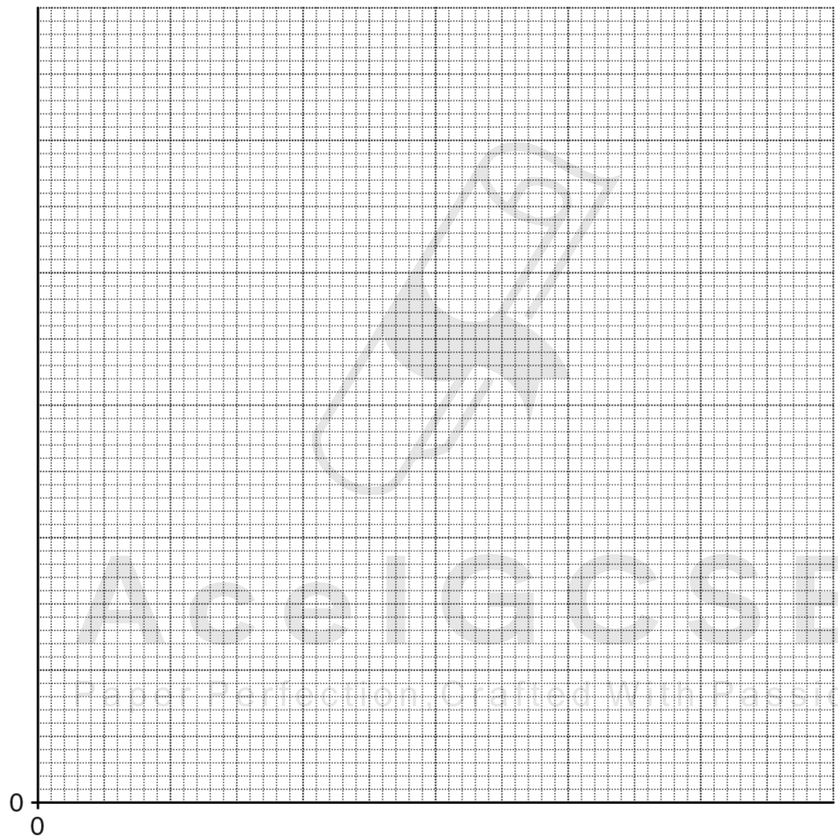
Suggest a precaution that you would take when measuring the length of the spring, to ensure a reliable reading. You may draw a diagram.

(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]

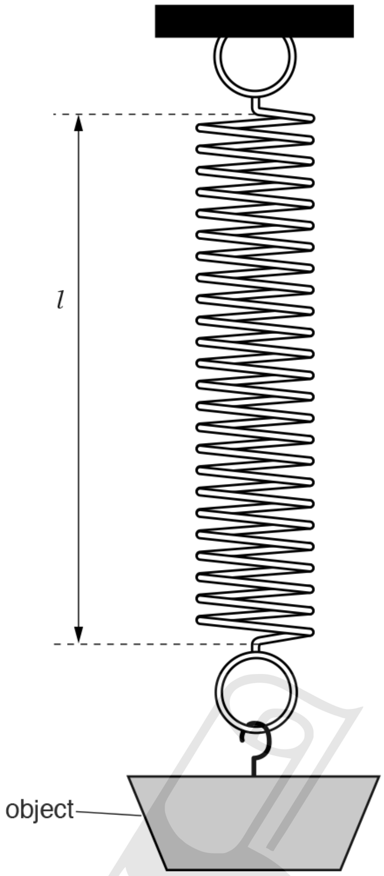


Fig. 2.2

(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]

38. 0625_s14_qp_61 Q: 1

The IGCSE class is investigating the motion of a mass hanging on a spring.

Fig. 1.1 shows the apparatus

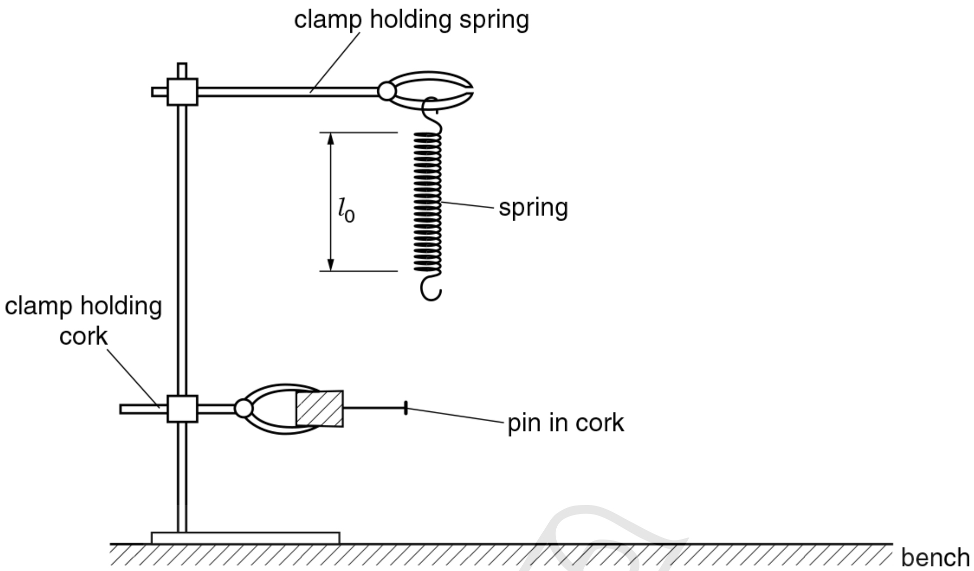


Fig. 1.1

(a) On Fig. 1.1, measure the length l_0 of the unstretched spring, in mm.

l_0 = ... mm [1]

(b) The diagram is drawn one tenth of actual size. Write down the actual length L_0 of the unstretched spring, in mm.

L_0 = ...mm [1]

A student hangs a 300 g mass on the spring and measures the new length L of the spring.

L = 255 mm

(i) Calculate the extension e of the spring using the equation $e = (L - L_0)$.

e = ...mm

(ii) Calculate a value for the spring constant k using the equation $k = \frac{F}{e}$, where F = 3.0 N. Include the appropriate unit.

k = ...

[2]

(c) The student adjusts the position of the lower clamp so that the pin is level with the bottom of the mass when the mass is not moving. She pulls the mass down a short distance and releases it so that it oscillates up and down. Fig. 1.2 shows one complete oscillation.

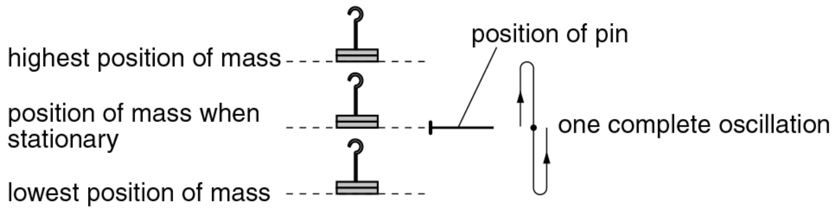


Fig. 1.2

She measures the time *t* taken for 20 complete oscillations.

t = 26.84 s

Calculate the time *T* taken for one complete oscillation.

T = ... [1]

(d) She replaces the 300 g mass with a 500 g mass. She repeats the timing as described in part **(c)**.

t = 34.48 s

(i) Calculate the time *T* taken for one complete oscillation.

T = ...

(ii) The student suggests that the time taken for the oscillations of the spring should not be affected by the change in mass.

State whether her results support this suggestion and justify your answer by reference to the results.

statement ....

justification ....

....

....
[2]

(e) Explain briefly how you avoid a line-of-sight (parallax) error when measuring the length of a spring in this type of experiment. You may draw a diagram.

....

....

....[1]

[Total: 8]

39. 0625_w14_qp_63 Q: 1

The IGCSE class is investigating the downward deflection of a metre rule clamped at one end.

The apparatus has been set up as shown in Fig. 1.1. The 0.0 cm mark is at the free end of the rule.

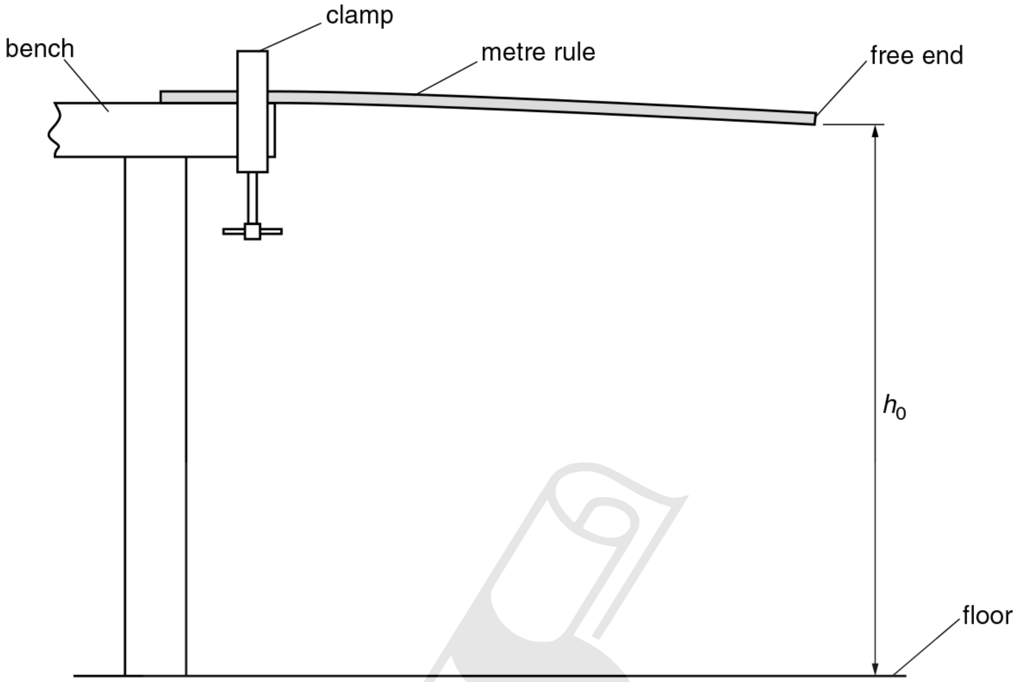


Fig. 1.1

(a) (i) On Fig. 1.1, measure h_0.

h_0 = ... cm

(ii) Fig. 1.1 is drawn to 1/10th scale.

Calculate and record the actual height H_0 of the free end of the metre rule above the floor.

H_0 = ... cm
[1]

(b) A student carefully places a mass on the rule at a distance d = 60.0 cm from the free end of the rule.

Explain how he could make sure that the centre of the mass was at this 60.0 cm mark. You may use a diagram.

....

....

.... [1]

(c) Fig. 1.2 shows the mass in place on the rule.

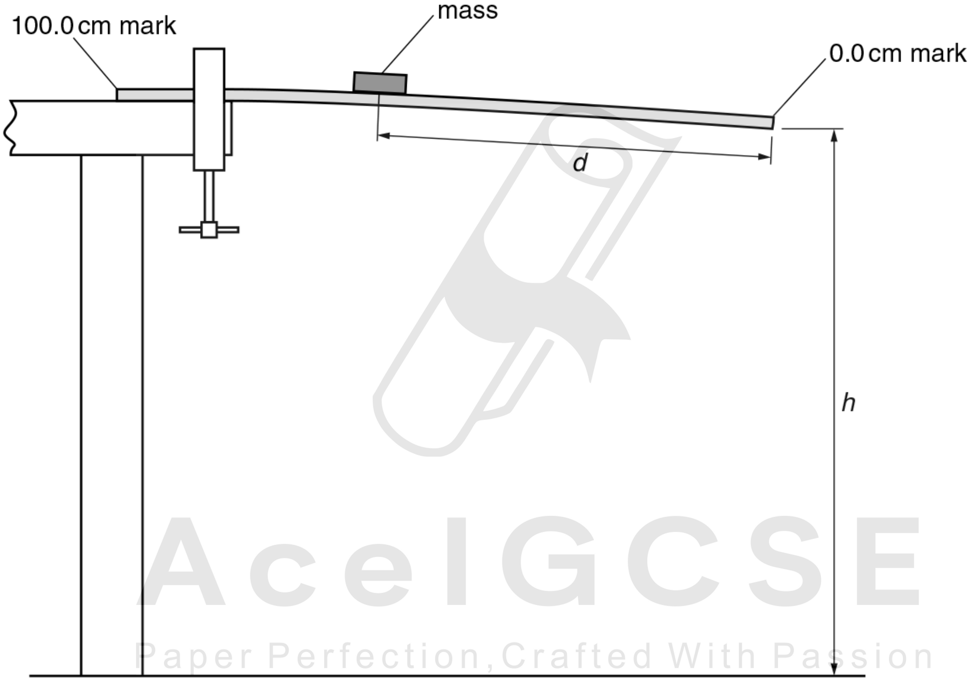


Fig. 1.2

(i) On Fig. 1.2, measure h.

h = ... cm

(ii) Fig. 1.2 is also drawn to 1/10th scale.

Calculate, and record in Table 1.1, the actual height *H* of the free end of the rule above the floor.

Table 1.1

d/cm	*H*/cm	*D*/cm	$(d \times D)$/cm^2
60.0			
50.0	82.5	1.5	
40.0	81.5	2.5	
30.0	80.3	3.7	
20.0	79.0	5.0	

[2]

(d) The procedure is repeated for *d* values of 50.0 cm, 40.0 cm, 30.0 cm and 20.0 cm. The results are shown in the table.

(i) For $d = 60.0$ cm, calculate and record in the table the downward deflection *D* (change in height) produced by the mass. Use the results from **(a)(ii)** and from the table, and the equation $D = H_0 - H$.

(ii) For each value of *d*, use the results from the table to calculate and record in the table the value of $(d \times D)$.

(e) A student suggests that the downward deflection *D* is inversely proportional to the distance *d* (that is, *D* is proportional to 1/*d*).

Using some appropriate figures from Table 1.1, explain why this cannot be the case.

....

....

.... [1]

(f) **(i)** Although the metre rule is flat when placed on the bench, one student notices that the free end is slightly deflected downwards when clamped as shown in Fig. 1.1, even when the mass is not placed on it.

Explain why this deflection occurs.

....

....

.... [1]

(ii) Suggest how to find the value of this deflection. You may draw a diagram.

....

....

.... [2]

[Total: 8]

40. 0625_s13_qp_61 Q: 1

The IGCSE class is investigating the stability of a block of wood.

Figs. 1.1 and 1.2 show the dimensions of the block.

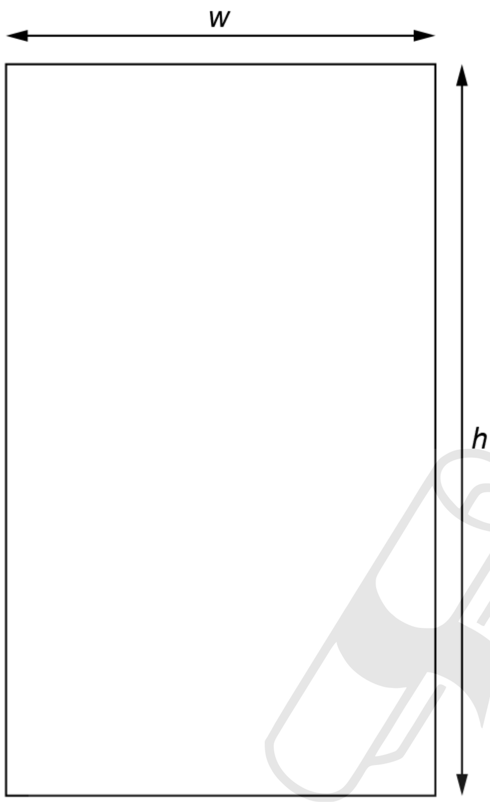


Fig. 1.1

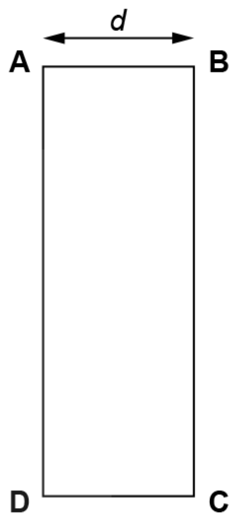


Fig. 1.2

(a) **(i)** On Figs. 1.1 and 1.2, measure the height *h*, width *w* and depth *d* of the block.

h = ...

w = ...

d = ...
[2]

(ii) On Fig. 1.2, draw the line **AC**. [1]

(iii) Measure and record the angle α between lines **AD** and **AC**.

α = ...[1]

(b) A student places the block on the edge of the bench, as shown in Fig. 1.3.

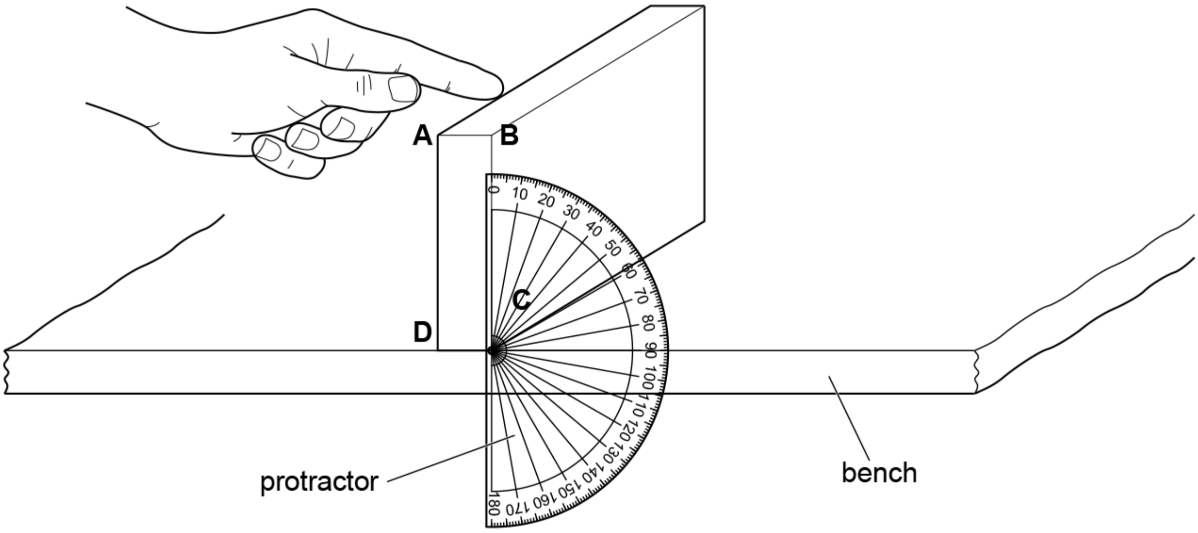


Fig. 1.3

He holds the protractor next to face **ABCD** of the block, as shown in Fig. 1.3. He gently pushes the top of the block (as indicated in Fig. 1.3) so that the block tips over.

He records the angle θ between side **BC** of the block and the vertical line on the protractor. The angle θ is when the block just tips over. He repeats this procedure a suitable number of times.

Suggest the number of measurements of θ that you think would be suitable for this experiment.

number = ... [1]

(c) The student calculates the average value θ_{av} of all his values for θ.

θ_{av} = ...20°......................

He suggests that θ_{av} should be equal to α. State whether the results support this suggestion. Justify your statement by reference to the results.

statement ....

justification ....

....

....
[2]

[Total: 7]

41. 0625_s13_qp_61 Q: 5

The IGCSE class is determining the mass of a load **X** using a balancing method.

Fig. 5.1 shows the apparatus.

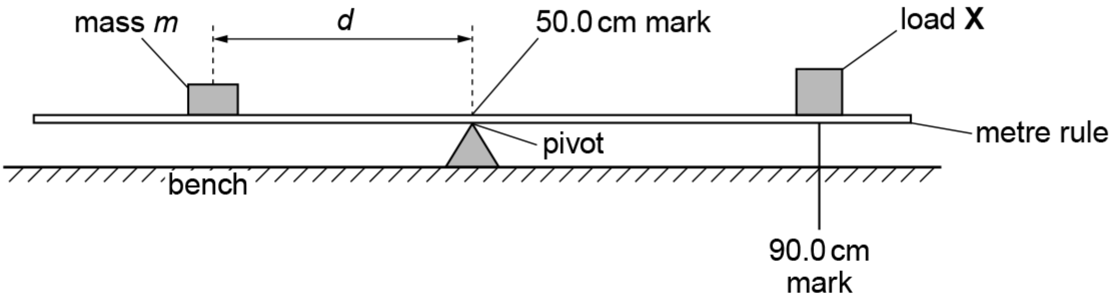


Fig. 5.1

The centre of the load **X** is fixed at the 90.0 cm mark on the rule.

A student uses a range of values of the mass *m* and determines the distance *d* from the pivot where the mass must be placed to balance the rule.
The readings are shown in Table 5.1.

Table 5.1

m / g	*d* / cm
40	30.2
50	23.9
60	20.0
70	17.1
80	15.1

(a) Calculate the distance *x* between the centre of the load **X** and the centre of the rule.

x = ... [1]

(b) Suggest a reason for the student using a range of *m* values.

....

....

.... [1]

(c) Using each set of readings and the value of *x*, the student calculates values for the mass of the load **X**.

He writes his results: 30.2 g, 29.875 g, 30 g, 29.925 g, 30.2 g.

Use these results to calculate an average value for the mass of **X** and give it to a suitable number of significant figures for this type of experiment.

average value for the mass of **X** = ... [2]

(d) This type of balancing experiment is difficult to carry out.

Suggest one practical difficulty and one way to try to overcome the difficulty. You may draw a diagram, if you wish.

practical difficulty ....

....

....

way to overcome the difficulty

....

....

[2]

[Total: 6]

42. 0625_s13_qp_62 Q: 1

The IGCSE class is determining the mass of a metre rule using two methods.

Method 1.

Fig. 1.1 shows the apparatus used.

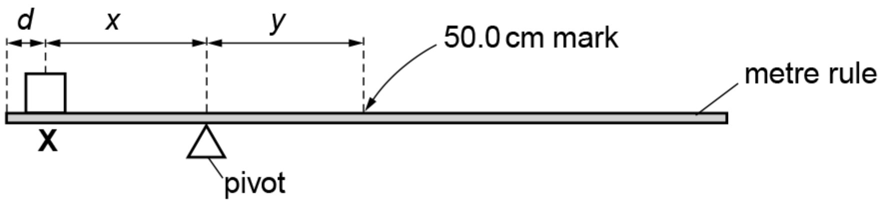


Fig. 1.1

A student places a 100 g mass **X** on the rule so that its centre is at a distance d = 5.0 cm from the zero end of the rule, as shown in Fig. 1.1. He adjusts the position of the rule so that it is as near as possible to being balanced.

He measures the distance x from the centre of the mass **X** to the pivot and the distance y from the pivot to the 50.0 cm mark on the rule.

He repeats the procedure using d = 10.0 cm.

The readings are shown in Table 1.1.

Table 1.1

d/cm	x/cm	y/cm
5.0	23.7	21.1
10.0	21.0	18.5

(a) **(i)** Using the values of x and y in the first row of the table, calculate the mass M of the rule using the equation

$$M = \frac{100x}{y}.$$

M = ...

(ii) Repeat step **(a)(i)** using the values of *x* and *y* in the second row of the table.

M = ...
[2]

(iii) Calculate the average value of *M*.

average value of *M* = ...[1]

Method 2.

(b) The student measures the mass *M* of the rule, using a spring balance as shown in Fig. 1.2.

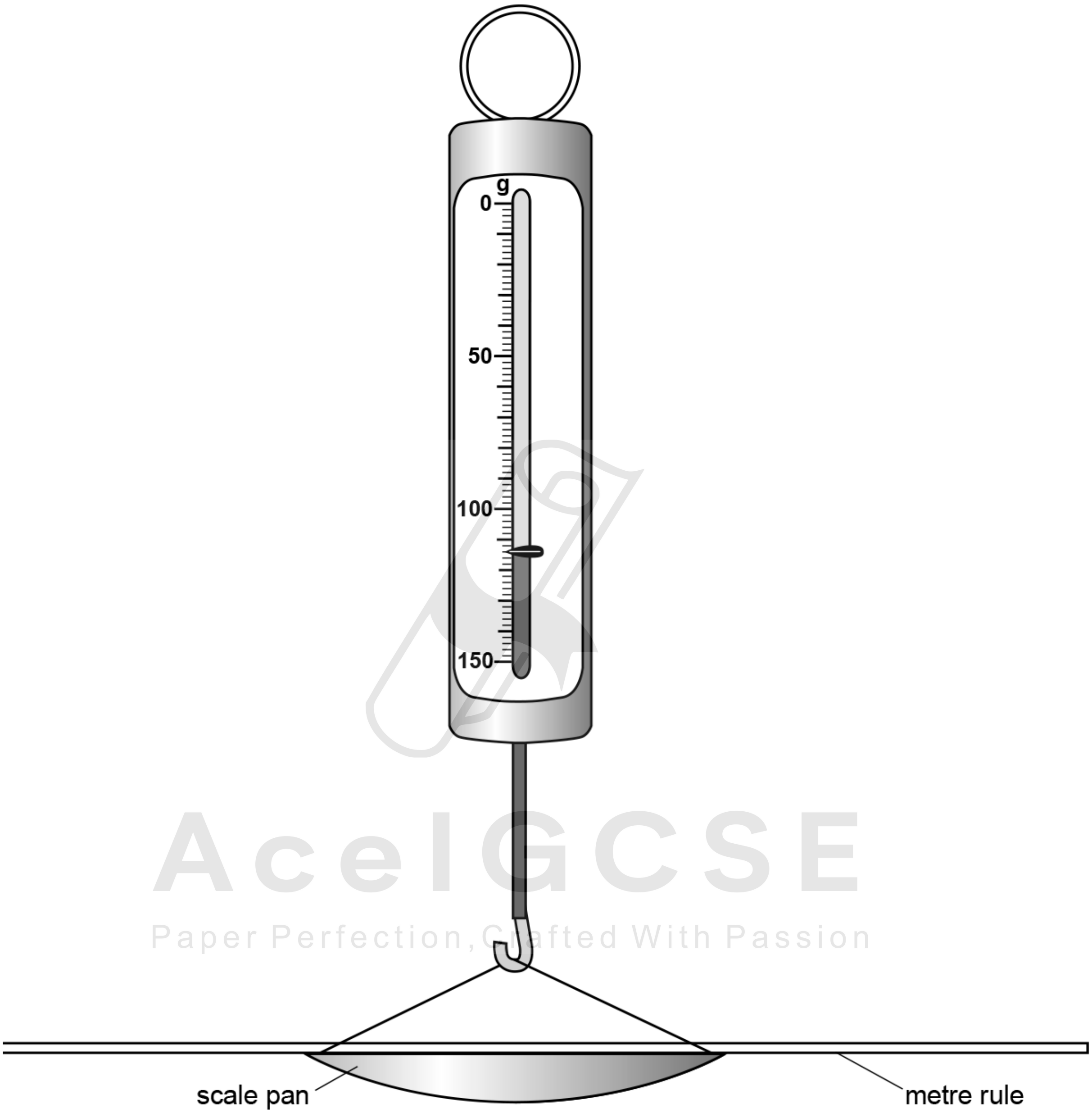


Fig. 1.2

Write down the reading shown in Fig. 1.2.

M = ...[1]

(c) The student expects that the values of the mass *M* obtained by the two methods will be exactly the same.

Suggest two practical reasons why, in spite of following the instructions with care, the values may differ. Assume that the balance used in Method 2 is accurate.

1. ....

....

2. ....

.... [2]

(d) Explain briefly how you would judge the position of the centre of the mass **X** when it is on the rule in Method 1. You may draw a diagram.

....

....

....[1]

[Total: 7]

43. 0625_w13_qp_61 Q: 1

The IGCSE class is carrying out a moments experiment by balancing a metre rule on a small pivot.

(a) A student has a small pivot and a metre rule.

Explain briefly how the student finds the position of the centre of mass of the metre rule.

....

....

....[1]

(b) The student finds that the centre of mass is not in the middle of the rule but at the 50.2 cm mark.

Explain what the student could do to prevent this from affecting her results.

....

....[1]

(c) The student places the metre rule on a pivot so that it balances.

She places a load **P** on one side of the metre rule at a distance *x* from the pivot. She places another load **Q** on the metre rule and adjusts the position of the load **Q** so that the rule balances, as shown in Fig. 1.1.

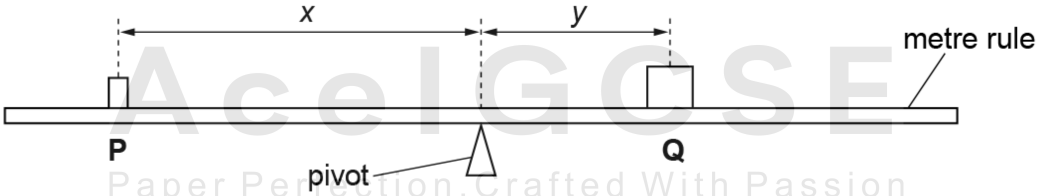


Fig. 1.1

The load **Q** is a distance *y* from the pivot.

The readings are shown in Table 1.1.

Table 1.1

weight of **P** / N	weight of **Q** / N	*x* /	*y* /
2.0	5.0	39.0	15.5

(i) Complete the column headings in the table. [1]

(ii) Calculate the clockwise moment and the anticlockwise moment using the equation

moment of a force = force × perpendicular distance to the pivot.

clockwise moment = ...

anticlockwise moment = ...
[1]

(d) In practice, it is difficult to adjust the loads to make the rule balance exactly.

Explain briefly how you would reduce the uncertainty in the position of **Q** required for exact balance.

....

....[1]

[Total: 5]

44. 0625_w13_qp_61 Q: 5

The IGCSE class is investigating the stretching of a spring.

Fig. 5.1 shows the apparatus.

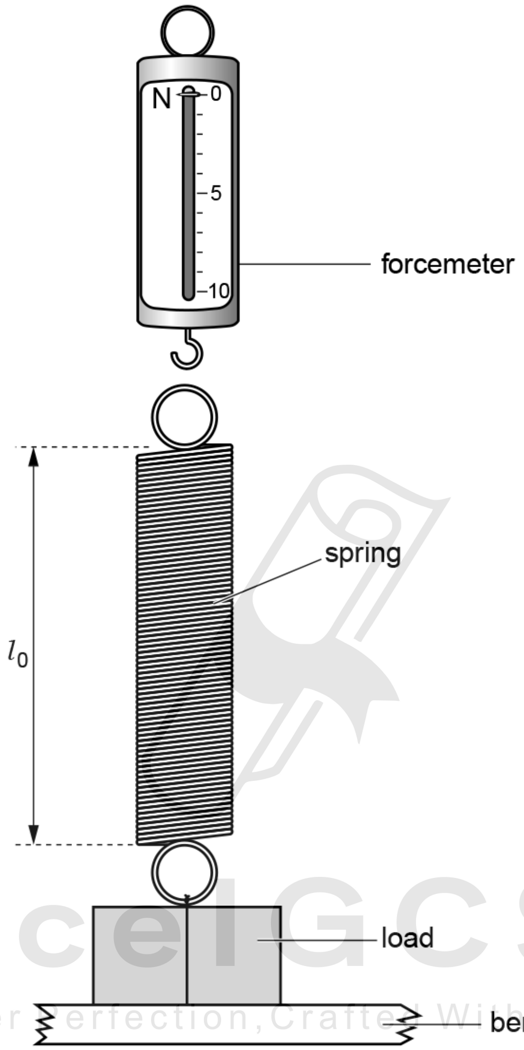


Fig. 5.1

(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]

---

45. 0625_s12_qp_61 Q: 1

An IGCSE student is determining the mass of a metre rule using a balancing method.

Fig. 1.1 shows the apparatus.

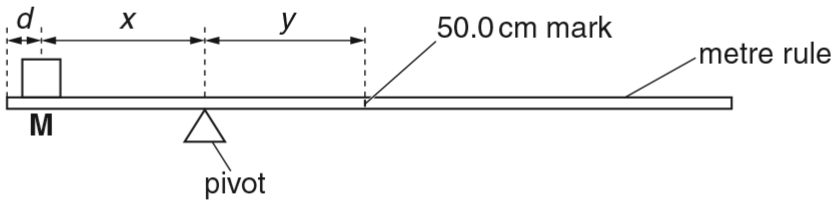


Fig. 1.1

Mass **M** is placed on the rule. The position of the pivot is adjusted until the rule balances.

(a) The student chooses a mass **M** which is similar to the mass of the metre rule. Suggest a suitable value for the mass.

suitable mass = ... [1]

(b) The mass is cylindrical and has a diameter slightly larger than the width of the metre rule.

Describe briefly how you would place the mass so that its centre of mass is exactly over the 90.0 cm mark on the metre rule. You should draw a diagram and mark the position of the centre of mass on the cylinder.

....

....

.... [2]

(c) From your experience of carrying out balancing experiments of this type, suggest one difficulty that you are likely to come across that could make the final result inaccurate.

....

....

.... [1]

(d) The student takes a reading of *x* and the corresponding reading of *y*. He then calculates the mass of the metre rule.

Suggest how you would improve the reliability of the value of the mass of the metre rule, using this method.

....

.... [1]

(e) Another student carries out a similar experiment to determine the mass of a 50 cm metal strip. She calculates the mass and writes down "mass = 234.872 g".

She checks the mass on an accurate balance. The value is 235 g. She thinks she must have made a mistake in her experiment.

Write a brief comment on the accuracy of her experimental result.

....

....

.... [1]

[Total: 6]

46. 0625_s12_qp_63 Q: 1

The IGCSE class is investigating the effect of a load on a metre rule attached to a forcemeter.

The apparatus is shown in Fig. 1.1.

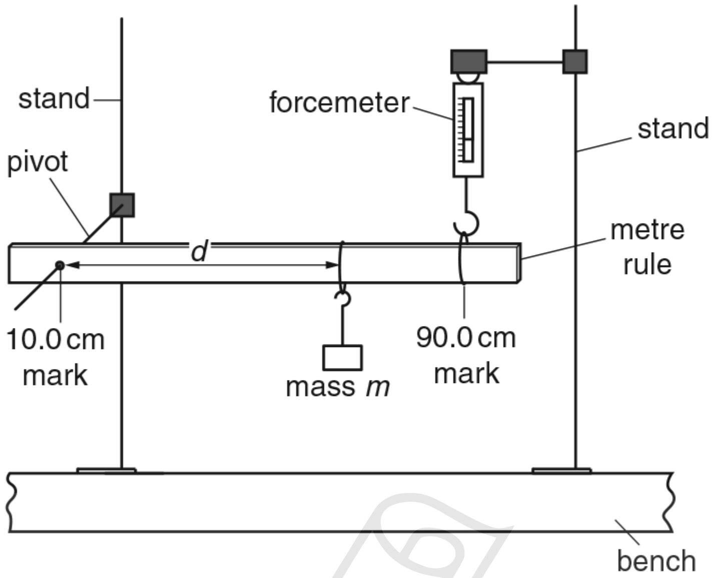


Fig. 1.1

The rule is pivoted near one end at the 10.0 cm mark. Near the other end, at the 90.0 cm mark, the rule is attached to a forcemeter. A mass is hanging from the rule at a distance *d* from the pivot.

(a) A student moves the mass to a distance *d* = 70.0 cm from the pivot. He adjusts the height of the forcemeter until the rule is again horizontal. He records the reading *F* on the forcemeter.

He repeats the procedure using *d* values of 60.0 cm, 50.0 cm, 40.0 cm, 30.0 cm, 20.0 cm and 10.0 cm. The forcemeter readings are shown in Table 1.1.

Table 1.1

d /	*F* /
	2.9
	2.5
	2.2
	1.8
	1.5
	1.2
	0.8

(i) Record the *d* values in the table.

(ii) Complete the column headings in the table. [2]

(b) The student thinks that *F* is directly proportional to *d*.

(i) Suggest the graph that you could plot to test this idea. You are not asked to plot the graph.

.... against ....

(ii) State the properties of the line that would indicate that *F* is directly proportional to *d*.

1. ....

2. ....
[3]

(c) A spirit level is a piece of equipment that is placed on a surface to check whether the surface is horizontal.

Suggest why a spirit level balanced on the rule is not suitable for checking whether the rule is horizontal in this experiment.

....

....[1]

(d) Describe briefly how you would check that the rule is horizontal in this experiment. You may draw a diagram.

....

....

....[1]

[Total: 7]

47. 0625_w12_qp_61 Q: 1

The IGCSE class is investigating the stretching of a spring.

Fig. 1.1 shows the experimental set up.

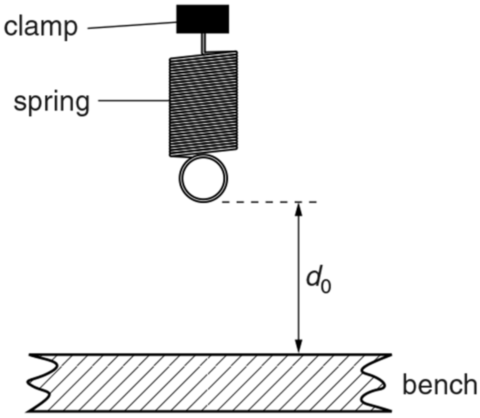


Fig. 1.1

(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.

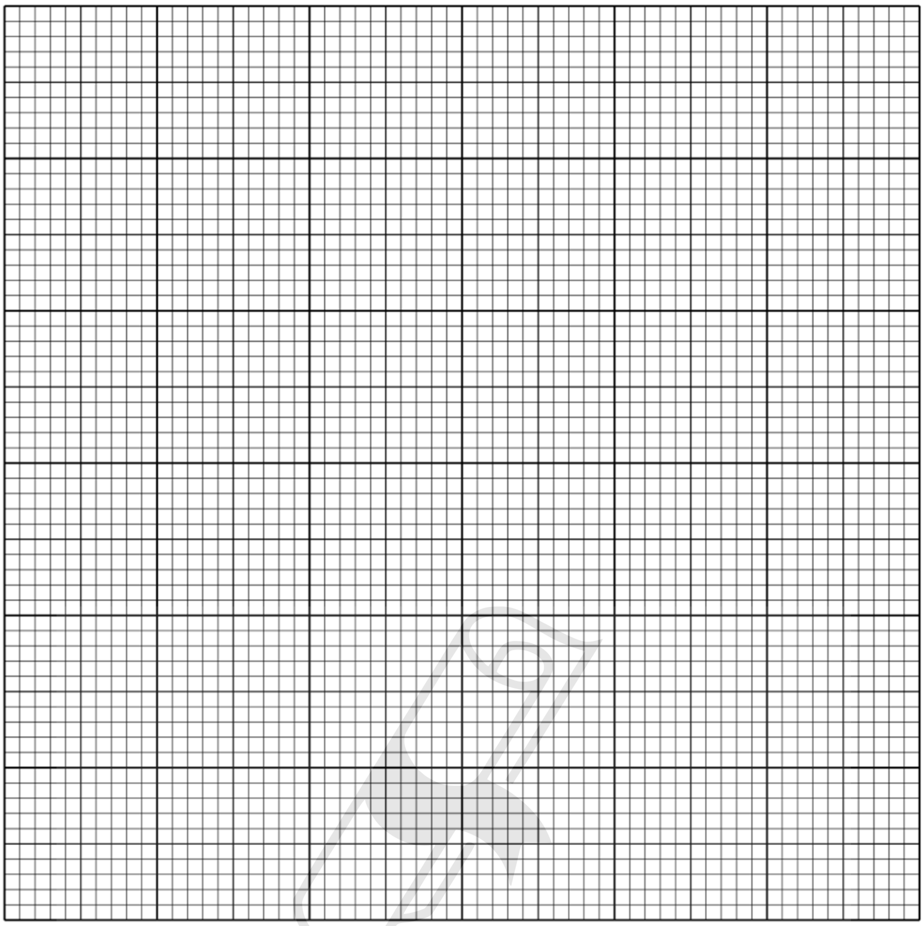
Calculate the extension e of the spring, for each set of readings, using the equation $e = (D_0 - D)$. Record the values of L and e in Table 1.1.

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]

48. 0625_w12_qp_63 Q: 1

An IGCSE class is carrying out this experiment to determine the mass of a metal block.

Fig. 1.1 shows a spring drawn full size.

Fig. 1.2, also full size, shows the spring with a load of 100 g suspended from it.

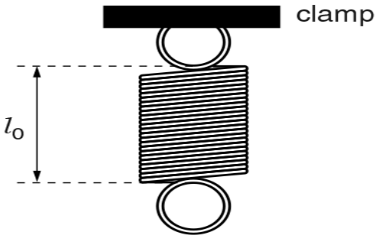


Fig. 1.1

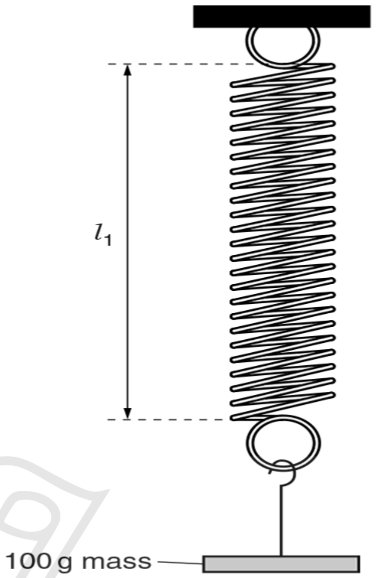


Fig. 1.2

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

l_0 = ... cm

(ii) On Fig. 1.2 measure the stretched length l_1, in cm.

l_1 = ... cm [1]

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

e_1 = ...[1]

(iv) Determine a value for k using the equation $k = \frac{m}{e_1}$, where m = 100 g.

k = ... unit ....[2]

(b) The apparatus is then set up as shown in Fig. 1.3.
The rule is at a small angle to the bench.

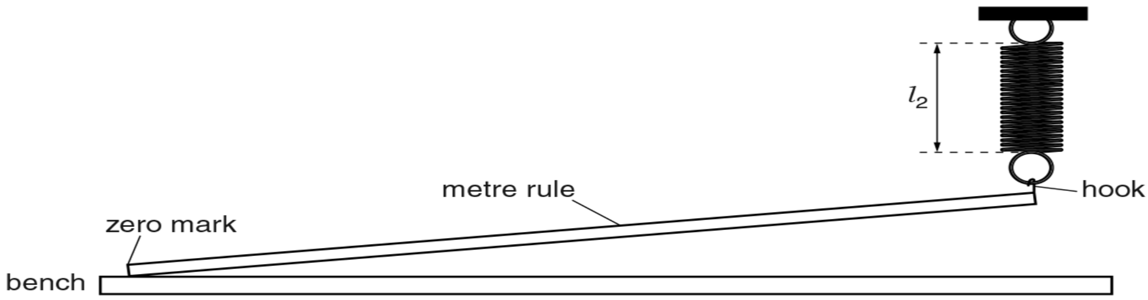


Fig. 1.3

A student measures the length of the stretched spring and obtains the result

l_2 = ...4.4 cm............

(i) He then places a metal block **X** with its centre at the 40.0 cm mark on the rule.

Explain briefly how the student can make sure that the block is in the correct position. You may wish to use a diagram.

....

....

.... [1]

(ii) The student measures the new length l_3 of the spring and records it as

l_3 = ...7.5 cm............

Determine the change in the extension e_2 due to block **X**, using the equation $e_2 = (l_3 - l_2)$.

e_2 = ...

(iii) Calculate the mass M of block **X** using your answers to **(a)(iv)** and **(b)(ii)** and the equation $M = k\left(\frac{e_2}{0.40}\right)$.

M = ... [2]

(c) Suggest two practical causes of inaccuracy in this experiment.

1. ....

....

2. ....

....
[2]

[Total: 9]

01. 0625_p20_MS_60 Q: 1

(a) table:
at least 2 d values correct: 30.0, 24.2, 19.8, 17.2, 15.0 (cm) to $\pm$ 0.5 cm
(accept values 50–d) [1]
rule readings subtracted from 50 cm [1]
all 5 d values correct: 30.0, 24.2, 19.8, 17.2, 15.0 (cm) to $\pm$ 0.2 cm [1]
1/d values correct (note: at least 2 significant figures) [1]

(b) any one difficulty and corresponding solution from:
difficulty obtaining balance as rule tips one way then the other
allow to tip one way then the other and take average

mass obscuring marks on rule
mark centre of the mass so it can be read against rule
OR take average of right hand and left hand readings for mass position

mass sliding off rule
OR rule sliding off pivot
suitable means for preventing mass or rule sliding [max 2]

(c) graph:
axes labelled with quantity and unit [1]
scales suitable, plots occupying at least half grid [1]
plots all correct to ½ square (take centre of plot if large) [1]
well-judged thin line ($\leq$ ½ square) [1]

(d) triangle method used and shown (any indication on graph) using at least half line
(can be seen in calculation) [1]

(e) μ = 27 – 33 (g) to 2 or 3 significant figures [1]

02. 0625_p20_MS_60 Q: 4

(a) apparatus:
measuring cylinder/jug OR ruler OR balance (to measure amount of water) [1]
protractor OR rule to measure height of raised surface
OR other means of measuring angle of tilt
OR newtonmeter to apply variable force
OR other method of applying quantifiable force [1]

instructions:
method of tilting or applying variable force and measuring point at which bottle topples [1]

attention to accuracy, any two from:
just starts to topple
slowly
repeats / more than 10 values for quantity of water
very large protractor
or any other suitable precaution which would improve accuracy of data [max 2]

values:
at least 5 values with range at least 1500 cm^3 or 30 cm or 1500 g, approximately evenly spaced [1]

graph:
plot of measured variable (angle or height or force) against quantity of water (volume or height or mass) (accept vice versa) [1]

(b) 20° [1]

---

03. 0625_s20_MS_61 Q: 1

(a)	0.025, 0.037, 0.050, 0.063, 0.075	1
	Consistent significant figures	1
(b)	Graph: Axes correctly labelled and right way round	1
	Suitable scales	1
	All plots correct to $\frac{1}{2}$ small square	1
	Good line judgement, thin, continuous line	1
(c)	(0.02) Method shown clearly on graph	1
	Value correct to $\frac{1}{2}$ small square	1
(d)	Clear wording or diagram	1
(e)(i)	Difficult to obtain balance point	1
(e)(ii)	Idea of obtaining nearest to balance	1

04. 0625_s20_MS_62 Q: 4

	MP1 diagram showing strip clamped to bench with majority overhanging	**1**
	MP2 means to measure bending, e.g. vertical metre rule at end of strip	**1**
	MP3 add load at / near end of strip and measure the amount of depression **MP4** repeat with other strips	**2**
	MP5 variables any **one** from: all strips to have same width / thickness / profile use of same load(s) allowance for unloaded depression	**1**
	MP6 table with columns for material, load and depression with correct units	**1**
	MP7 strip that bends most with same load is most bendy / alternative wording	**1**

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05. 0625_s20_MS_63 Q: 1

(a)(i)	l = 15.0 (cm)	**1**
	centre of weight at 25(.0) cm seen or implied / clear subtraction of 10.0 cm from candidate's value	**1**
(a)(ii)	1.3 (N)	**1**
(a)(iii)	ensure distances from bench at both ends are equal OR use set square between rule and stand OR align with known horizontal line (e.g. window ledge)	**1**
(b)	graph: • axes labelled with quantity and unit	**1**
	• appropriate scales (plots occupying at least $\frac{1}{2}$ grid)	**1**
	• plots all correct to $\frac{1}{2}$ small square and precise plots	**1**
	• well judged line <u>and</u> thin line	**1**
(c)(i)	F_0 correct from graph	**1**
(c)(ii)	W_R in range 1.2 to 2.0	**1**
(d)	hang load from cotton loop on metre rule <u>and</u> cotton can be placed on precise mark on metre rule	**1**

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06. 0625_m19_MS_62 Q: 4

	MP1 **apparatus:** means of measuring dependent variable (e.g. stop watch / rule / protractor)	1
	MP2 **method** (one from): workable means of providing air resistance (e.g. fix card to rod / bob), allow pendulum to swing, suitable measurement (e.g. period, amplitude)	1
	MP3 repeat for different value of independent variable (e.g. area of card)	1
	MP4 **control variable** (one from): length of pendulum, angle of release, mass of bob	1
	MP5 **table:** suitable clear format with column headings and units	1
	MP6 **analysis:** compare readings to see if change in air resistance produces change in dependent variable (e.g. change in area of card changes period) / plot graph	1

	MP7 **additional point** (one from): time 10 oscillations / swings (and calculate period), small angle of swing, at least 5 sets of data taken, repeat each measurement and take average, adjust mass of pendulum to compensate for changing mass of card, repeat with different length of pendulum / mass of bob, length measured to centre of bob / centre of gravity of pendulum, use of fiducial aid	1

07. 0625_s19_MS_61 Q: 1

(a)	Graph:	
	Axes correctly labelled with quantity and unit and right way round	**1**
	Suitable scales	**1**
	All plots correct to ½ small square	**1**
	Good line judgement, thin, continuous line	**1**
(b)	triangle method indicated on graph	**1**
	triangle at least half of candidate's line	**1**
(c)	Correct calculation	**1**
	2 or 3 significant figures and unit N	**1**
(d)	Difficulty in achieving exact balance OR difficulty in judging centre of P OR load easily slips OR top of pivot not a sharp edge	**1**
(e)	113	**1**
(f)(i)	1.13	**1**
(f)(ii)	Statement and explanation to match results. Expect Yes, because values are close, owtte	**1**

08. 0625_s19_MS_62 Q: 1

(a)	centre of mass/gravity not in centre (however expressed)	1
(b)	graph:	
	axes correctly labelled and right way round	1
	suitable scales starting from (0,0)	1
	all plots correct to less than ½ small square	1
	good line judgement, thin, continuous line	1
(c)	triangle method used and <u>seen on graph</u>	1
	triangle at least half of distance between extreme plotted points i.e. $\Delta a \geqslant 10$	1
(d)	intercept correct to ½ small square – if graph not extrapolated, use the ruler tool	1
(e)	width 2.5(0) cm / 25 mm with correct unit	1
(f)	statement to match results	1
	justification to match statement and include idea of within (or beyond) limits of experimental accuracy	1
(g)	difficulty in achieving exact balance/keeping the pivot in the same position/locating the centre of load (Q)/load(s) slipping/load obscuring readings on rule	1

09. 0625_s19_MS_63 Q: 1

(a)	(difficult to see centre of block) and valid method, e.g. • (measure width of block and) add ½ width to 5.0 cm to find position for edge of block • mean value of marks at both edges of mass • mark centre line of mass and align with mark on rule	1
(b)(i)	move block back and forth to find the point of balance / owtte	1
(b)(ii)	graph:	
	axes labelled correct orientation, with quantity and unit	1
	appropriate scales (plots occupying at least ½ grid)	1
	plots all correct to less than ½ small square and precise plots	1
	well-judged line <u>and</u> thin line	1
(c)(i)	*G* present <u>and</u> triangle method seen on graph	1
(c)(ii)	M_U in range 61.0 to 81.0 (g)	1
	2/3 sig figs and unit	1
(d)	*a* and *b* are proportional	1
	b/*a* constant within limits of experimental accuracy / owtte	1

10. 0625_w19_MS_61 Q: 1

(a)(i)	*b* 16.9	1
(a)(i)	*a* / *b* 1.37 (ecf allowed)	1
(b)	Graph:	
	Axes correctly labelled and right way round	1
	Suitable scales	1
	All plots correct to ½ small square	1
	Good line judgement, thin, continuous line	1
(c)	triangle method indicated on graph	1
	triangle at least half of candidate's distance between extreme plots	1
(d)	Correct calculation, *W* = *G*	1
	to 2 or 3 significant figures	1
(e)	Balance on pivot with no load – balance point is at c of m	1
(f)	Obtaining a stable balance	1

11. 0625_w19_MS_61 Q: 4

	MP1 How the ball will move: Back and forth / like a pendulum	1
	MP2 Release from a determined position, time until stops	1
	MP3 Repeat with at least two more values of independent variable	1
	MP4 Statement of variable to be changed	1
	MP5 Statement of a variable to keep constant	1
	MP6 Table with columns for chosen variable that is changed and time with correct units, s for time.	1
	MP7 Compare chosen variable with time. Or plot graph of chosen variable against time	1

12. 0625_w19_MS_63 Q: 3

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

13. 0625_m18_MS_62 Q: 1

(a)	measure width of mass and add ½ width to mark at edge of mass / mean value of marks at both edges of mass / mark centre line of mass <u>and</u> edge of rule / line up mark through gap in slotted mass	**1**
(b)	method such as: find point which just tips one way move rule to find point which just tips other way	**1**
	balance point is between these where rule tips either way / owtte	**1**
(c)(i)	graph:	
	• axes labelled correct orientation, with quantity and unit	**1**
	• appropriate scales (plots occupying at least ½ grid)	**1**
	• plots all correct to ½ small square <u>and</u> precise plots	**1**
	• well judged line <u>and</u> thin line	**1**
(c)(ii)	*G* present <u>and</u> triangle method seen on graph	**1**
(c)(iii)	M_R in range 100 g to 400 g	**1**
	2 / 3 significant figures and unit	**1**
(d)	more accurate <u>and</u> errors have less effect (with larger values) / less % uncertainty	**1**

14. 0625_s18_MS_62 Q: 4

	method to include:	
	place truck on ramp (and release)	**1**
	measure distance (travelled) from bottom of ramp	**1**
	repeat with different mass(es) (loaded on the same truck)	**1**
	additional apparatus:	
	(metre) rule(r) / measuring tape	**1**
	control variables:	
	height / angle of ramp / number of supporting bricks	**1**
	release position / height above bench	**1**
	table with clear columns for mass, and distance travelled, with appropriate units <u>in the headings of the table</u>	**1**

15. 0625_s18_MS_63 Q: 4

	Apparatus: forcemeter, (10 g and 100 g) masses / masses only (if clear they are used to change the mass of the block and as weights to the block via the pulley)	**1**
	Diagram: block, workable means of pulling and measuring force	**1**
	Method (2): measure force required to make block slide / find mass (on pulley) required to make block slide	**1**
	repeat for new value of mass	**1**
	Precautions: any **one** from: same surface to slide on / repeat each measurement and take average / same angle of pulling force	**1**
	Graph: mass on block vs force (needed to slide)	**1**
	Any additional point: at least 5 sets of data taken / keep force horizontal / add mass of block to load / extra precaution	**1**

16. 0625_w18_MS_61 Q: 1

(a)	l_0 = 22 (mm)	**1**
(b)(i)	*e* = 31 (mm) ecf allowed	**1**
(b)(ii)	*k* = 0.0968 (N / mm) ecf allowed	**1**
(c)(i)	*t* = 3.46 (s)	**1**
(c)(ii)	T= 0.346 (s) T^2 = 0.12 (0.1197)	**1**
	units s and s^2	**1**
(c)(iii)	*k* = 0.1	**1**
(d)	Statement matches results	**1**
	Idea of within (or beyond) limits of experimental accuracy <u>explained</u>, e.g. close (enough), very close, nearly the same; (too) far apart	**1**
(e)	At least 3 additional values given	**1**
	Values between 50 g and 600 g	**1**

17. 0625_w18_MS_62 Q: 1

(a)	l_0 = 23 (mm)	**1**
(b)	recognisable set-square shown from spring to rule along one of the dotted lines	**1**
(c)(i)	*e* values 8, 17, 23, 32, 40	**1**
(c)(ii)	N, mm, mm	**1**
(d)	Graph:	
	axes correctly labelled and right way round	**1**
	suitable scales, at least ½ the grid used	**1**
	all plots correct to ½ small square	**1**
	good line judgement, thin, continuous line	**1**
(e)	triangle method used and seen on graph	**1**
	at least half of candidate's line used	**1**
(f)	answers within the range 0.025 ± 0.005 (N / mm) and expressed to 2 / 3 significant figures only	**1**

18. 0625_m17_MS_62 Q: 4

	apparatus: MP1 springs made by winding wire around rod (or similar)	**1**
	method: MP2 apply load, measure length / extension of spring	**1**
	MP3 repeat for spring(s) of different material	**1**
	MP4 record results in suitable annotated table / bar chart / graph	**1**
	control variables: MP5 mark gained for any two of: unstretched length of spring, diameter of wire, coil spacing, load / range of loads used diameter of spring	**1**
	MP6 **precautions / difficulties / additional points:** MP7 any two from: clamp retort stand / might topple, use small loads / spring might overstretch/spring too weak/use loads which don't overstretch spring to support loads need to apply force smoothly / slowly, suggested range of loads, workable arrangement for applying load to spring (e.g. small loop at end of spring) trial experiment to find (range of) loads to use how to determine extension of spring, repeat each reading and take average, at least 5 loads for each sample if producing graph	**2**
	Total:	**7**

19. 0625_s17_MS_61 Q: 1

(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**

20. 0625_s17_MS_62 Q: 4

(a)	graph: axes correctly labelled	**1**
	suitable scales	**1**
	all plots correct to ½ small square	**1**
	good line judgement, thin, continuous line	**1**
(b)	expect NO line does not pass through origin	**1**
(c)	6,40,34	**1**
	consistent units of N cm	**1**
(d)	have not taken the weight of the rule/moment of the weight into account/not realised that $Qb + mX = Pa$ /the pivot is not at the centre (of mass) of the rule	**1**
	Total:	**8**

21. 0625_w17_MS_61 Q: 4

(a)	1 / *Q* values 1.(0), 0.5(0), 0.33(3), 0.25, 0.2(0)	1
(b)	Graph:	
	Axes correctly labelled and right way round	1
	Suitable scales	1
	All 5 plots correct to ½ small square	1
	Good line judgement, thin, continuous line	1
(c)(i),(ii)	At least half line used for triangle method	1
	Clearly shown on graph	1
	P = 1.8 – 2.2 (N)	1
(d)	1.9	1
(e)	Two from: Difficulty in obtaining balance Difficulty in judging centre of loads Loads may slip / slide Forcemeter not sensitive Forcemeter zero error	2

22. 0625_w17_MS_62 Q: 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

23. 0625_w17_MS_63 Q: 3

(a)(i)	F = 0.75	1
(a)(ii)	any reliable method e.g. equal distances between rule and bench in at least two places, line up with named horizontal surface, use of set-square between stand and rule	1
(b)	graph:	
	axes labelled with quantity and unit	1
	appropriate scales (plots occupying at least ½ grid and scales starting at 0,0)	1
	plots all correct to ½ small square AND precise plots	1
	Well-judged line AND thin line	1
(c)(i)	F_0 correct from graph	1
(c)(ii)	W_R in range 0.90 to 1.4	1
	2 / 3 sig figs and unit (N)	1
(d)	statement matching plotted points AND explanation referring to line and scatter of data	1
(e)	repeat all readings and take average	1

24. 0625_p16_MS_60 Q: 1

(a) table:
at least 2 *d* values correct: 30.0, 24.2, 19.8, 17.2, 15.0 (cm) to ± 0.5 cm
(accept values 50–*d*) [1]
rule readings subtracted from 50 cm [1]
all 5 *d* values correct: 30.0, 24.2, 19.8, 17.2, 15.0 (cm) to ± 0.2 cm [1]
1/*d* values correct (note: at least 2 significant figures) [1]

(b) any one difficulty and corresponding solution from:
difficulty obtaining balance as rule tips one way then the other
allow to tip one way then the other and take average

mass obscuring marks on rule
mark centre of the mass so it can be read against rule
OR take average of right hand and left hand readings for mass position

mass sliding off rule
OR rule sliding off pivot
suitable means for preventing mass or rule sliding [max 2]

(c) graph:
axes labelled with quantity and unit [1]
scales suitable, plots occupying at least half grid [1]
plots all correct to ½ square (take centre of plot if large) [1]
well-judged thin line (≤ ½ square) [1]

(d) triangle method used and shown (any indication on graph) using at least half line
(can be seen in calculation) [1]

(e) μ = 27 – 33 (g) to 2 or 3 significant figures [1]

25. 0625_p16_MS_60 Q: 4

(a) apparatus:
measuring cylinder/jug OR ruler OR balance (to measure amount of water) [1]
protractor OR rule to measure height of raised surface
OR other means of measuring angle of tilt
OR newtonmeter to apply variable force
OR other method of applying quantifiable force [1]

instructions:
method of tilting or applying variable force and measuring point at which bottle topples [1]

attention to accuracy, any two from:
just starts to topple
slowly
repeats / more than 10 values for quantity of water
very large protractor
or any other suitable precaution which would improve accuracy of data [max 2]

values:
at least 5 values with range at least 1500 cm^3 or 30 cm or 1500 g, approximately evenly spaced [1]

graph:
plot of measured variable (angle or height or force) against quantity of water (volume or height or mass) (accept vice versa) [1]

(b) 20° [1]

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26. 0625_s16_MS_61 Q: 1

(a)(i)	*A* and *B* values correct *A:40.0, 35.0, 30.0, 25.0, 20.0* *B:34.0, 28.8, 24.0, 19.2, 14.0*	1
(a)(ii)	cm, cm, N cm, N cm	1
(b)	Graph:	
	Axes correctly labelled with quantity, right way round	1
	Appropriate scales, starting at origin (0,0)	1
	All plots correct to ½ small square	1
	Good line judgement, thin, continuous, single line through the plots; with neat plots	1
(c)	Method shown on graph and Y correct to ½ small square.	1
(d)	*W* = 1.0–1.4. No ecf	1
(e)	Difficulty of achieving balance or other sensible suggestion	1
(f)	Expect agree; allow ecf. Explanation includes idea of close enough (or, ecf, too different)	1
		Total 10

27. 0625_s16_MS_62 Q: 1

(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

28. 0625_s16_MS_62 Q: 2

(a)	*x* shown clearly from centre of **P** to pivot	1
(b)	Make **Q** into a cube / regular shape / small contact area with rule	1
(c)	Move Q or P slowly one way until it just tips, then back other way until it tips back and take middle reading OR repeat procedure / experiment **AND** take average	1
(d)	Measure width w of cube Place w / 2 either side of desired position <u>OR</u> draw centre line on cu e / find centre of mass of cube and mark side of rule in desired position <u>OR</u> take readings on both sides of the cube and find the mean	1 1
(e)	Place rule on pivot (without P and Q) and record / find balance point	
		Total: 6

29. 0625_s16_MS_63 Q: 2

(a)	indication of taking mean reading / deducing half load length <u>and</u> adding or subtracting scale reading = 70(.0)	1 1
(b)	*F* values=1.45, 2.20, 2.80, 3.55, 4.05 consistent 2 dp	1 1
(c)	**graph:** • axes labelled with quantity and unit • appropriate scales (plots occupying at least ½ grid) • plots all correct to ½ small square • well judged straight line <u>and</u> thin line, precise plots	 1 1 1 1
(d)(i)	*y* read correctly from graph	1
(d)(ii)	*W* in range 1.4 to 2.0 to 2 or 3 sig fig and with unit of N	1 1
(e)	any suitable source on inaccuracy, e.g.: • rule not uniform / weight not distributed evenly, • load slips on rule, • forcemeter not at zero to start, • load values not exact	1
		Total: 12

30. 0625_w16_MS_61 Q: 5

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

31. 0625_w16_MS_62 Q: 1

(a)(i)	*x* = 30.2(cm)	1
(a)(ii)	Measure width w of load Place w / 2 either side of desired position OR draw centre line on load / find centre (of mass) of load and mark **side** of rule in desired position OR take readings on both sides of the load and find the mean	1 1
(b)	W = 3.95 (N)	1
(c)	new *x* at least 5 cm different from original and in the range 10 cm–45 cm	1
(d)	**two** from: difficult to judge the best position of 'almost balanced' is the centre of mass of the ruler exactly over the pivot / has the ruler slipped on the pivot? the load(s) obscure the scale the position of the centre of the load(s) is difficult to judge	2
(e)	3.995 or 4 seen 2 or 3 significant figures (whatever the answer)	1 1
	Total:	**9**

32. 0625_w16_MS_63 Q: 4

	apparatus – workable arrangement	1
	how applied force is measured	1
	suitable table for results / plot a bar graph	1
	how to conclude which is strongest	1
	one suitable control variable: e.g. same width of sample same thickness / weight / length of paper all samples fixed in same way	1
	any 2 from: 2nd control variable, force applied smoothly / no jerking ensure no tears before applying force repeat for each type of sample / repeat with samples of different widths soft mat under weights (to cushion fall) / clamp stand to bench add weight of lower block to value of load any other suitable precaution	2
	Total	**7**

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33. 0625_m15_MS_62 Q: 1

(a) measure ½ mass length either side of 95.0 cm
OR mark side of mass AND rule [1]

(b) correct calculations of *S*, rounding to 0.17, 0.33, 0.51, 0.61, 0.80 [1]

(c) axes labelled with quantity and unit [1]
appropriate scales [1]
plots correct to ½ small square [1]
well-judged straight line, thin line, precise plots [1]

(d) **(i)** *G* present AND triangle method seen on graph [1]

(ii) M_R = in range 113 to 140 g AND to 2/3 sig. fig. [1]

(e) see if rule balances when pivot at 50 cm mark owtte [1]

[Total: 9]

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34. 0625_s15_MS_61 Q: 1

(a) x = 1.4 (cm) or 14 (mm) or 0.014 (m)
AND y = 2.6 (cm) or 26 (mm) or 0.026 (m) [1]

correct unit for x and y [1]

(b) X and Y both 10 × x and y, ecf **(a)** [1]

W = 1.08 (N), to 2 or more significant figures (ecf allowed) [1]

(c) sensible position indicated for Z, between pivot and centre of rule [1]

(d) statement matches results
(expect Yes, ecf from **(b)** only if difference >10%) [1]

justified with reference to results; must include idea of being close enough to be within limits of experimental accuracy, ecf **(b)** [1]

(e) difficulty in achieving balance OR difficulty in positioning load exactly, e.g. load covers rule markings or uncertainty about position of centre of mass of load [1]

[Total: 8]

35. 0625_s15_MS_63 Q: 1

(a) a_0 = 75.5 (cm) AND b_0 = 25.9 (cm), accept in mm [1]

matching unit [1]

(b) a_1 = 71.(0) AND b_1 = 32.9 [1]

d_A = 4.5 and d_B = 7.(0), allow ecf from earlier results [1]

(c) *M* value rounds to160 (g), allow ecf from **(b)** [1]

2 or 3 sig. figs. and unit: g [1]

(d) appropriate explanation, e.g.
- measure height (from bench)/distance from rule at two places
- line up with rule or suitable horizontal surface
- use of spirit level [1]

(e) repeat with different (sized) loops/different values (of d_A, d_B) [1]

any one from:
- (at least) 3 more sets of results and evaluate d_A:d_B
- plot a graph to (check if) a straight line through the origin [1]

[Total: 9]

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36. 0625_w15_MS_62 Q: 1

(a)(i)(ii) *x* = 40 mm / 4(.0) cm AND *y* = 19 mm / 1.9 cm
both with correct unit [1]

(iii) 40(.0) AND 19(.0) in first line of table [1]

(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 line judgement, single, thin, continuous line [1]

(c) triangle method using at least half candidate's line, shown on graph [1]

G = 0.41–0.52 (2–3 sig. figs. only) [1]

(d) **P** = 20–500 g [1]
Q = 2 × **P** (exactly) OR Q = **P**/*G* [1]

[Total: 10]

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37. 0625_w15_MS_63 Q: 2

(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]

38. 0625_s14_MS_61 Q: 1

(a) (b) 21 (mm) [1]

210 (mm) ecf from l_0 [1]

(b) 45 (mm) and
0.067 or 0.0667 (N / mm), 2 or 3 sig. figs.
ecf from l_0 and L_0 [1]

correct unit N / mm or N / m or N / cm as appropriate [1]

(c) T = 1.342 (s) or 1.34 (s) [1]

(d) T = 1.724 s (no mark)
statement NO (ecf from **(c)**) [1]

difference too large (for experimental inaccuracy) (ecf) [1]

(e) clear diagram or explanation that indicates:
perpendicular viewing of spring or scale
OR appropriate use of horizontal pointer / set square / rule, etc.
OR rule touching / very close to spring [1]

[Total: 8]

39. 0625_w14_MS_63 Q: 1

(a) h_0 present and H_0 = 84(.0) (cm) [1]

(b) suitable explanation,
e.g. same no. of graduations between 60 cm mark and each end of mass owtte,
or mark on side of rule and mass [1]

(c)(d) h present and H = 83(.0) [1]

D = 1(.0) and $d \times D$ calculations correct: 60, 75, 100, 111, 100 [1]

(e) $d \times D$ not constant / D doesn't always double when d halves owtte [1]

(f) **(i)** reference to mass/weight of rule [1]

(ii) measure height at bench [1]

subtract H_0 [1]

[Total: 8]

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40. 0625_s13_MS_61 Q: 1

(a) 9.7, 5.7, 2.0 (accept 2) or 97, 57, 20 [1]
all given to correct unit [1]
line AC drawn correctly, corner to corner [1]
α = 18 – 20° [1]

(b) number from 3 to 20 with no unit [1]

(c) correct statement for results (expect Yes) [1]
idea of within (or beyond) experimental accuracy [1]

[Total: 7]

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41. 0625_s13_MS_61 Q: 5

(a) 40.0 or 40(cm) [1]

(b) accuracy / reliability / check readings / spot anomaly / o.w.t.t.e. [1]

(c) correct method used [1]
30 or 30.0(g) [1]

(d) rule never quite balances, o.w.t.t.e. [1]
take average position / nearest to balance, o.w.t.t.e. [1]

[Total: 6]

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42. 0625_s13_MS_62 Q: 1

(a) **(i)(ii)** *M* values 112.3, 113.5 (to 3 or 4 sig. figs **only)** [1]
g at least once, not contradicted (symbols or words) [1]

(iii) 113 or 112.9 or correct average of candidate's values (ignore sig. figs) [1]

(b) 114 (g) c.a.o. [1]

(c) any two from:
centre of mass of rule not at 50.0 cm
mass X not uniform / of varying density
reference to difficulty in obtaining balance implied o.w.t.t.e.
mass of pan
mass not exactly 100 g [2]

(d) one from:
mark line through the centre of the mass (can award from diagram)
use position of edges of mass on rule
[1]

[Total: 7]

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43. 0625_w13_MS_61 Q: 1

(a) rule balanced <u>and</u> pivot at centre of mass [1]

(b) EITHER take readings from 50.2 cm mark
OR add mass/weight/load
OR place pivot at 50.2 cm mark [1]

(c) **(i)** cm, cm [1]

(ii) clockwise 77.5 (or 78) (N cm)
anticlockwise 78 (N cm) [1]

(d) EITHER repeats
OR estimate between two best positions that almost balance but tip opposite sides o.w.t.t.e
OR suitable method to locate centre of mass **Q** [1]

[Total: 5]

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44. 0625_w13_MS_61 Q: 5

(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]

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45. 0625_s12_MS_61 Q: 1

(a) 50–250 g (or 0.05–0.25 kg) correct unit required [1]

(b) Centre of mass marked close to centre of cylinder [1]
Clear indication of how centre of mass is placed above the 90.0 cm mark [1]

(c) Rule unlikely to exactly balance/ difficult to balance
OR rule could slide on pivot
OR mass could slide
OR centre of mass of rule not at 50.0 cm mark
OR rule not uniform1

Do not accept comments about poor/careless technique [1]

(d) Repeat readings (wtte) [1]
OR a reference to finding exact position of centre of mass of metre rule
OR a reference to dealing with centre of mass of rule not being at 50.0 cm mark

(e) Good/ fine/ reasonable/ same to 3 significant figures
OR Within limits of experimental accuracy (wtte)
OR Too many significant figures in experimental result [1]

[Total: 6]

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46. 0625_s12_MS_63 Q: 1

(a) Table:
correct *d* values
70.0, 60.0, 50.0, 40.0, 30.0, 20.0, 10.0 [1]
cm, N ALLOW m, mm if consistent with figures [1]

(b) **(i)** *d* against *F* (or vice versa) OR distance against force/forcemeter reading
NOT 'extension', 'forcemeter', quantity expressed just as units [1]

(ii) Straight line [1]
Through origin or wtte [1]

(c) Would change forcemeter reading/change mass on rule/wtte [1]

(d) Check distance from bench is the same at two points or wtte/
Line up by eye with windowsill (or suitable horizontal reference) [1]

[Total: 7]

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47. 0625_w12_MS_61 Q: 1

(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 and 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]

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48. 0625_w12_MS_63 Q: 1

(a) **(i)** and **(ii)** l_o = 2.0 <u>and</u> l_1 = 6.1 [1]

(iii) e_1 = 4.1cm unit required ecf from **1(a)(i)** and **1(a)(ii)** [1]

(iv) Correct calculation for k = 24/24.4 ecf from **1(a)(iii)** [1]
Unit g/cm [1]

(b) **(i)** Appropriate method (can be written and/or in diagram)
e.g. <u>measure</u> half width of mass either side of 40 cm/<u>mark</u> centre of mass [1]

(ii) and **(iii)** e_2 seen and M = 190 g (no ecf) unit required for M [1]
2 or 3 significant figures [1]

(c) Any two from:
rule bends
mass not exactly at 40 cm
mass may slip
end of rule may slip
hook not directly above 0 cm
spring extension not uniform/owtte
proportional limit exceeded
mass irregular/C of G not at centre [2]

[Total: 9]