Moments/Centre of Mass

Question Paper 2

Level	IGCSE
Subject	Physics
Exam Board	CIE
Topic	General Physics
Sub-Topic	Moments/ Centre of Mass
Paper Type	Alternative to Practical
Booklet	Question Paper 2

Time Allowed: **57 minutes**

Score: **/47**

Percentage: **/100**

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.

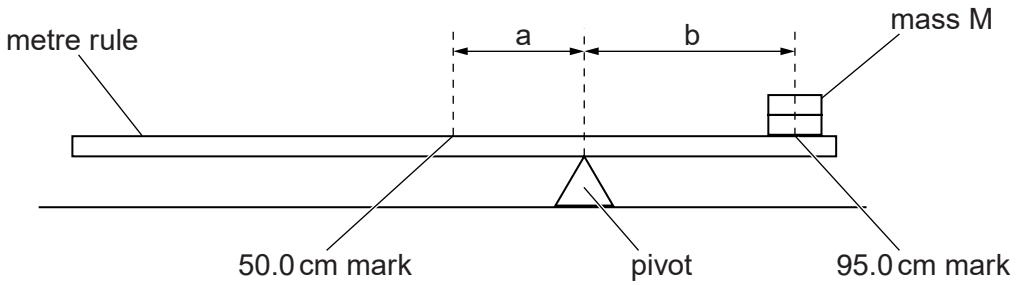


Fig. 1.1

(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.

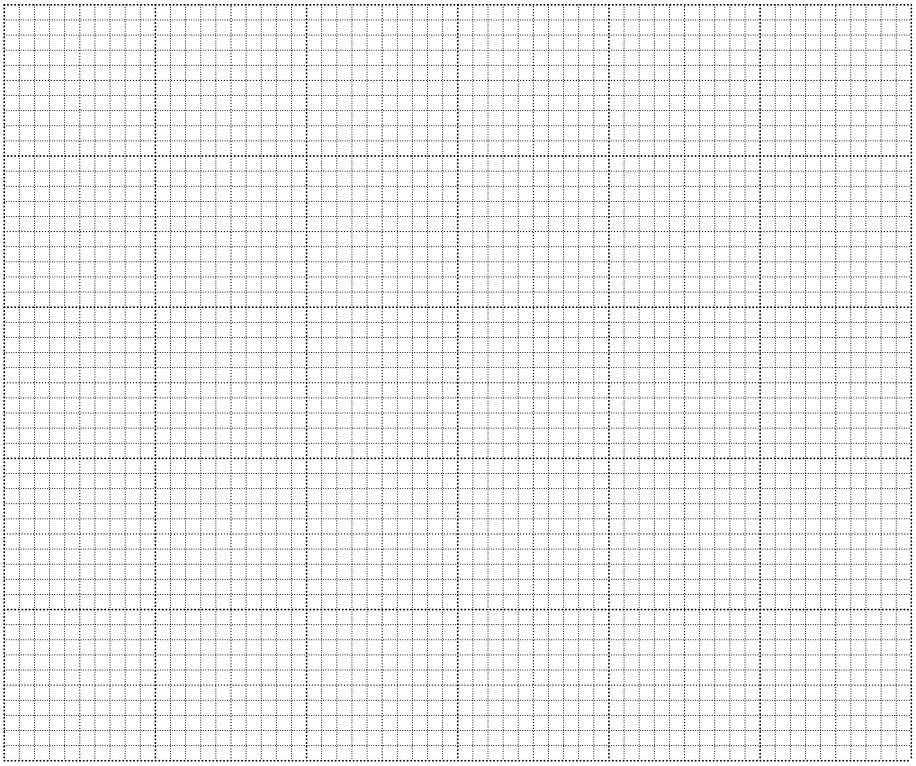
He repeats the procedure for values of M = 40 g, 60 g, 80 g and 100 g. His results are shown in Table 1.1.

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]

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

Fig. 1.1 shows the apparatus.

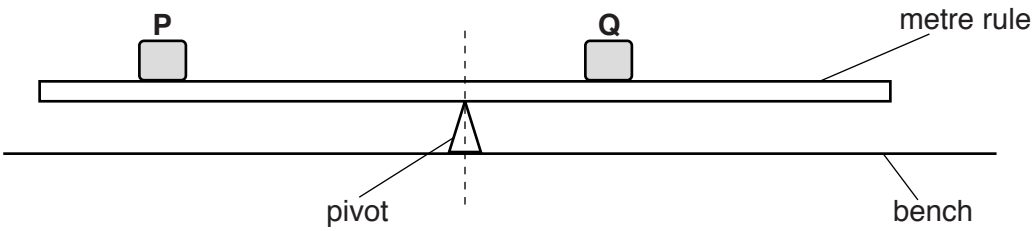


Fig. 1.1

(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.

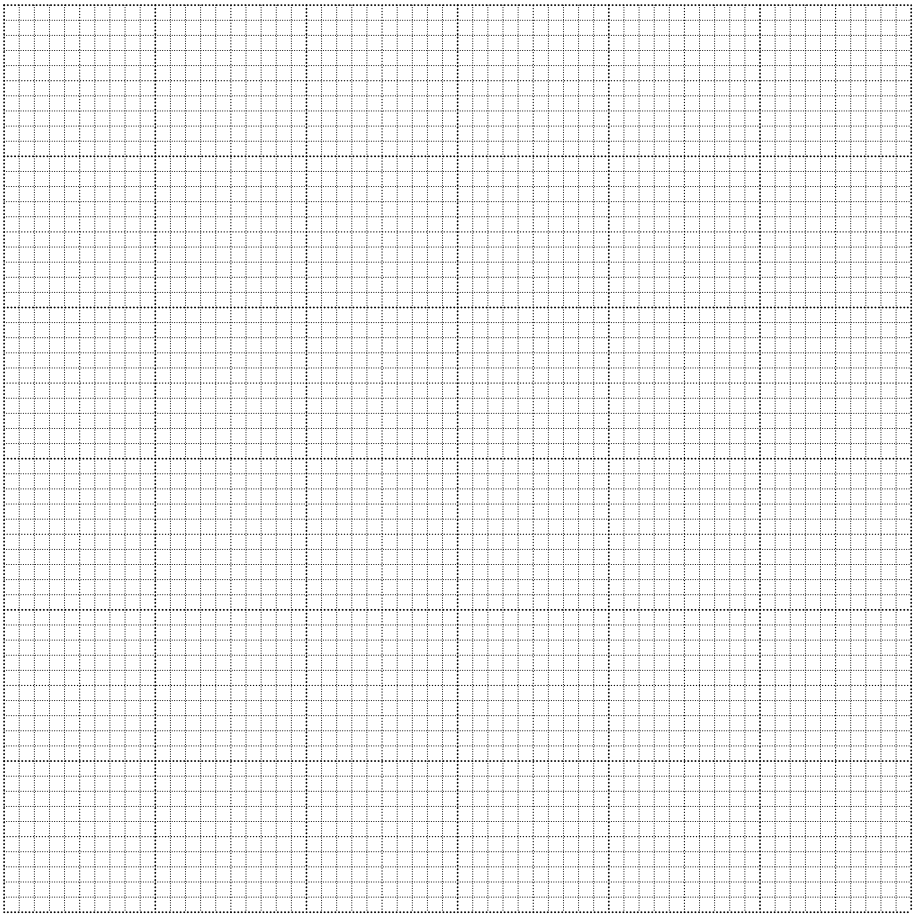
Calculate the actual distance *a* from the centre of load **P** to the pivot. Calculate the actual distance *b* from the pivot to the centre of load **Q**. Write the results in Table 1.1. [1]

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]

3 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.

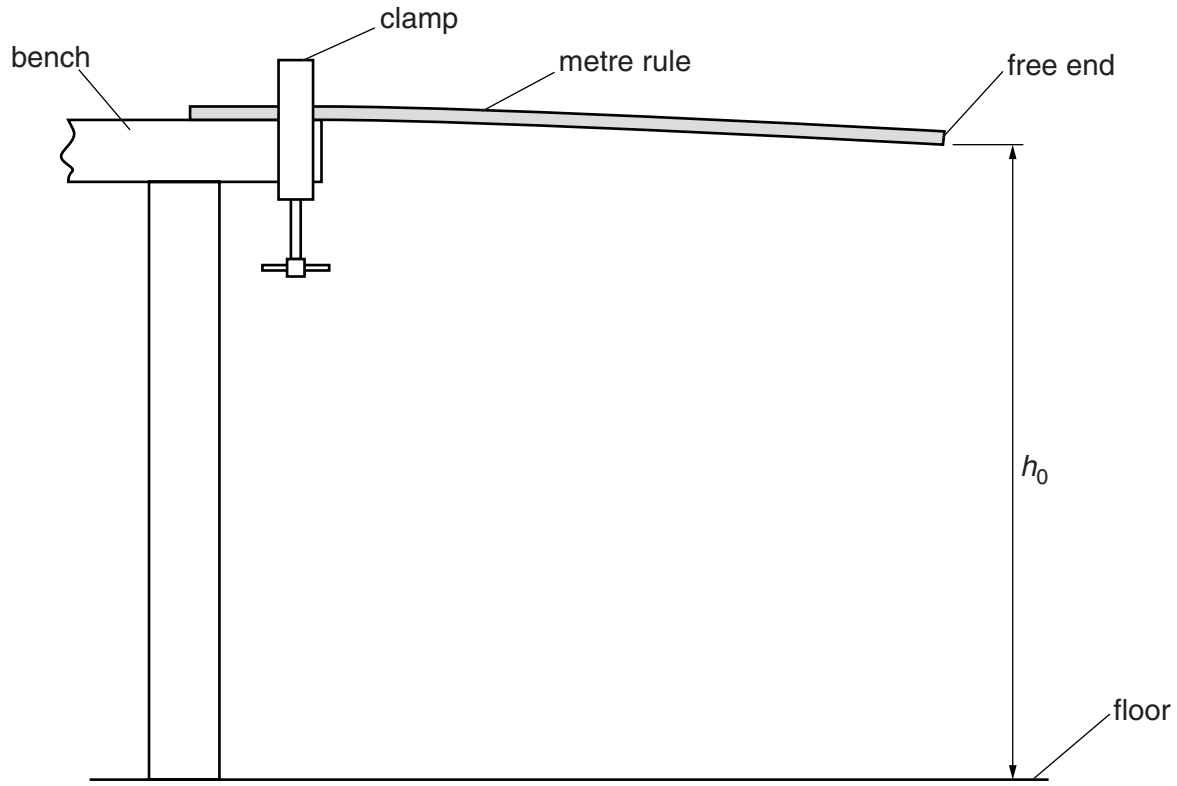


Fig. 1.1

(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 $d = 60.0\,\text{cm}$ 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.

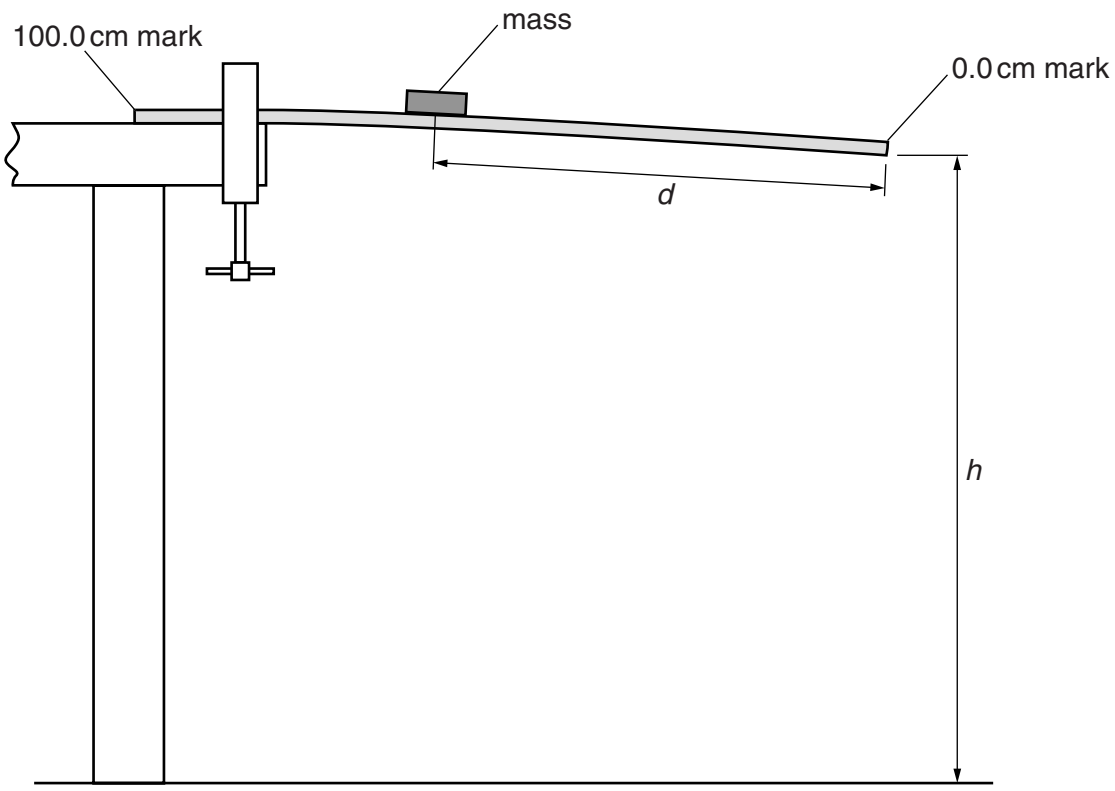


Fig. 1.2

(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]

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

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

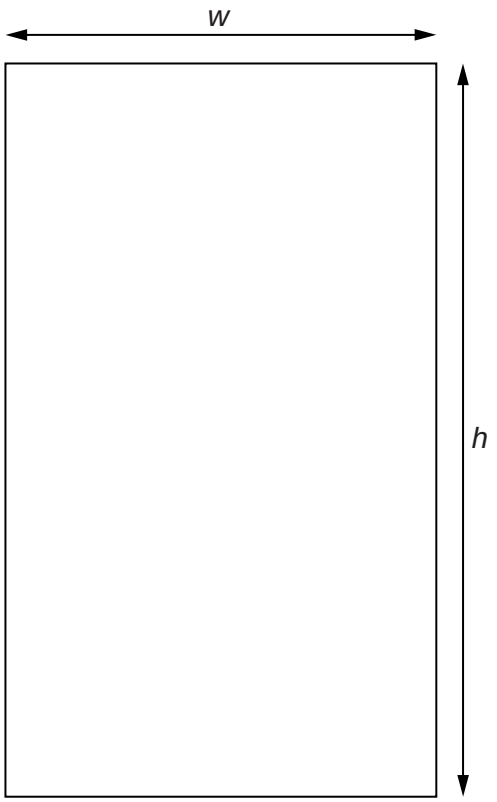


Fig. 1.1

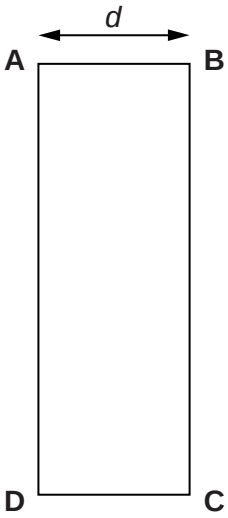


Fig. 1.2

(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.

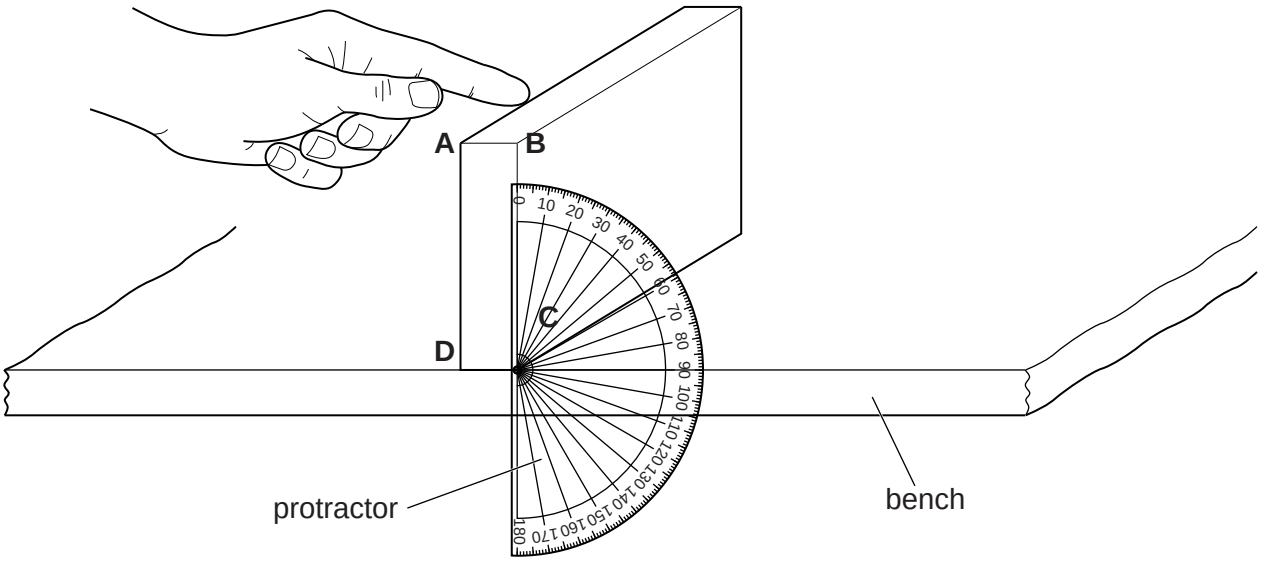


Fig. 1.3

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]

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

Fig. 5.1 shows the apparatus.

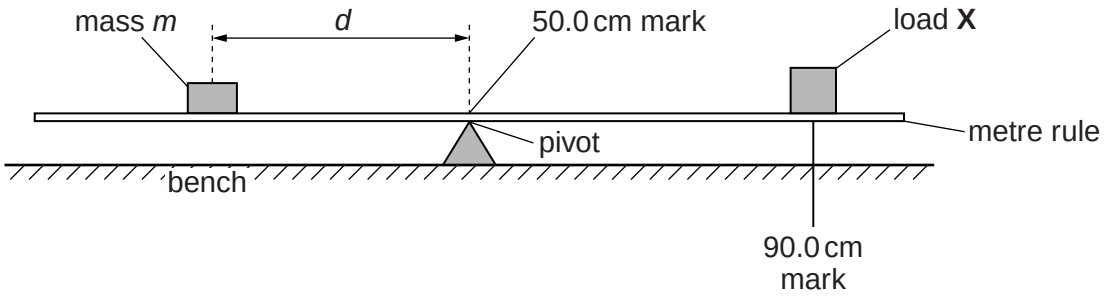


Fig. 5.1

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]

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

Method 1.

Fig. 1.1 shows the apparatus used.

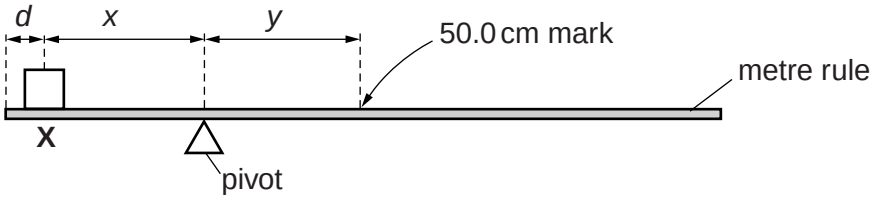


Fig. 1.1

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.

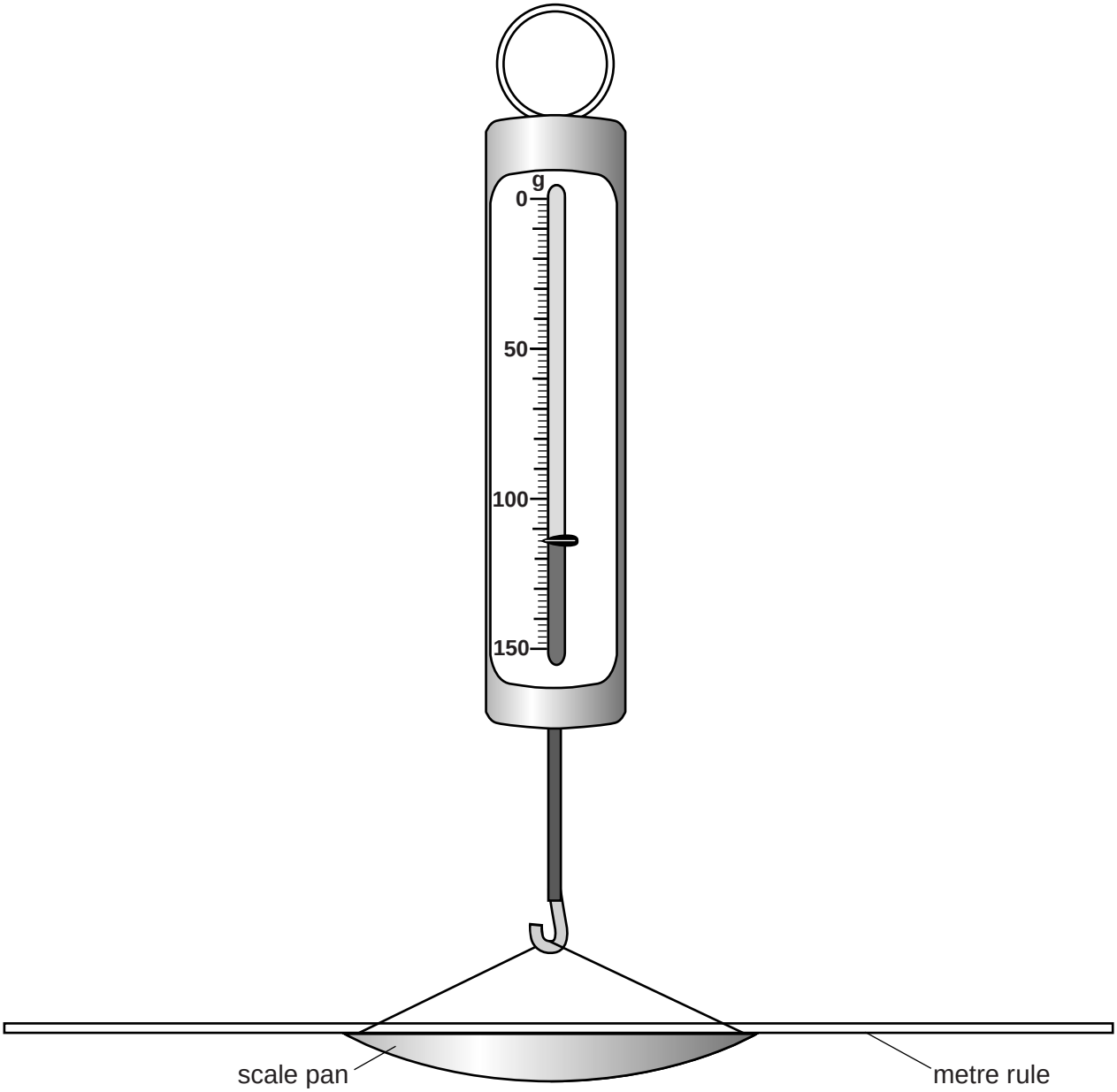


Fig. 1.2

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]