

# Moments/Centre of Mass

## Question Paper 4

|                   |                          |
|-------------------|--------------------------|
| <b>Level</b>      | IGCSE                    |
| <b>Subject</b>    | Physics                  |
| <b>Exam Board</b> | CIE                      |
| <b>Topic</b>      | General Physics          |
| <b>Sub-Topic</b>  | Moments/ Centre of Mass  |
| <b>Paper Type</b> | Alternative to Practical |
| <b>Booklet</b>    | Question Paper 4         |

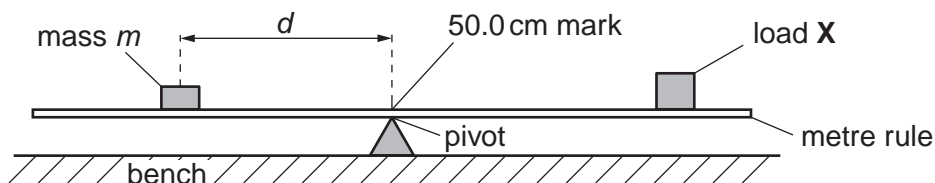
**Time Allowed:** 68 minutes

**Score:** /56

**Percentage:** /100

- 1 The IGCSE class 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. This is repeated using a range of masses. The readings are shown in Table 1.1

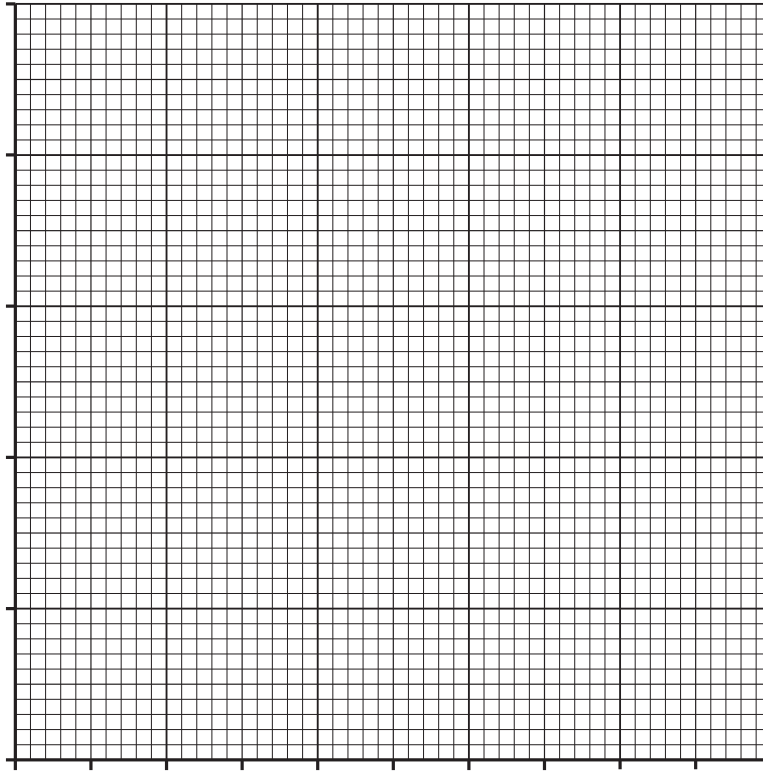
**Table 1.1**

| $m/g$ | $d/cm$ | $\frac{1}{d} / \frac{1}{cm}$ |
|-------|--------|------------------------------|
| 40    | 30.2   |                              |
| 50    | 23.9   |                              |
| 60    | 20.0   |                              |
| 70    | 17.1   |                              |
| 80    | 15.1   |                              |

- (a) For each value of  $d$ , calculate  $1/d$  and record it in the table.

[2]

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



[4]

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

$G = \dots\dots\dots$  [2]

(d) Determine the mass  $\mu$  of the load **X** using the equation  $\mu = G/k$  where  $k = 40.0 \text{ cm}$ .

$\mu = \dots\dots\dots$  [2]

- 2 A student is determining the position of the centre of mass of an object using a balancing method.

Fig. 1.1 shows the apparatus used.

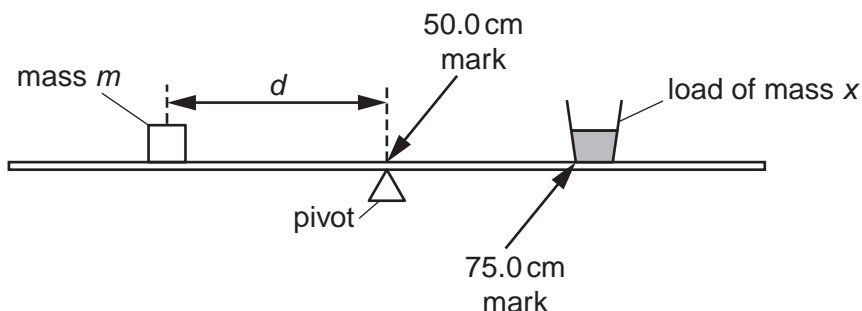


Fig. 1.1

A load of mass  $x$  is taped to the metre rule so that one side of the base is exactly on the 75.0 cm mark. The student places a mass  $m$  of 30 g on the rule and adjusts its position so that the rule is as near as possible to being balanced with the 50.0 cm mark exactly over the pivot, as shown in Fig. 1.1.

The student records the distance  $d$  from the centre of the 30 g mass to the 50.0 cm mark on the rule. He then repeats the procedure using different masses. The readings are shown in Table 1.1.

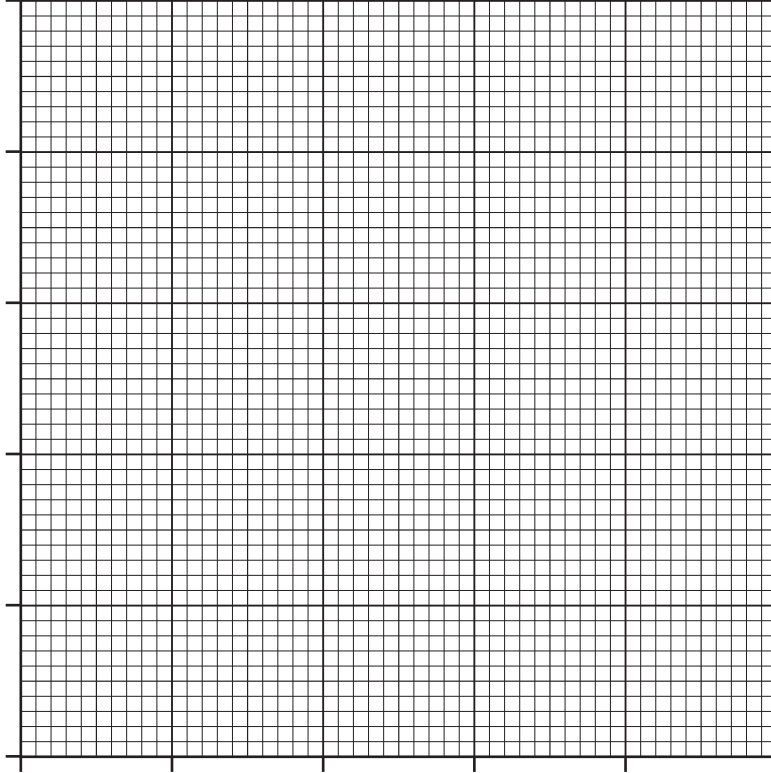
Table 1.1

| $m/g$ | $d/cm$ | $\frac{1}{d} / \frac{1}{cm}$ |
|-------|--------|------------------------------|
| 30    | 45.0   |                              |
| 40    | 34.0   |                              |
| 50    | 27.0   |                              |
| 60    | 22.5   |                              |
| 70    | 19.3   |                              |

- (a) For each value of  $d$ , calculate  $1/d$  and enter the values in the table.

[2]

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



[4]

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

$G = \dots\dots\dots$  [2]

(d) Determine the horizontal distance  $z$  from the 75.0cm mark on the rule to the centre of mass of the load using the equation

$$z = \frac{G - k}{x},$$

where  $k = 1250 \text{ g cm}$  and  $x = 50 \text{ g}$ .

$z = \dots\dots\dots$  [2]

[Total: 10]

3 An IGCSE student is determining the density of the material of a metre rule.

Fig. 1.1 shows the balancing experiment used to determine the mass of the rule.

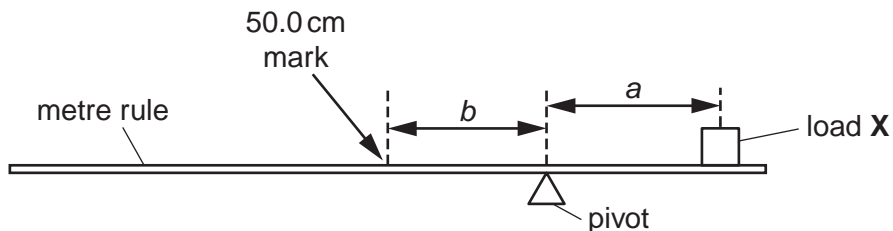


Fig. 1.1

(a) (i) On Fig. 1.1, measure the distance  $a$  from the centre of the load **X** to the pivot.

$a = \dots\dots\dots$  cm

(ii) On Fig. 1.1, measure the distance  $b$  from the pivot to the 50.0 cm mark on the rule.

$b = \dots\dots\dots$  cm  
[1]

(b) The diagram is drawn one tenth of actual size.

(i) Calculate the actual distance  $x$  from the centre of the load **X** to the pivot.

$x = \dots\dots\dots$  cm

(ii) Calculate the actual distance  $y$  from the pivot to the 50.0 cm mark on the rule.

$y = \dots\dots\dots$  cm

(iii) Calculate the mass  $m$  of the metre rule using the equation

$$m = \frac{kx}{y}$$

where  $k = 100$  g.

$m = \dots\dots\dots$   
[2]

(c) Figs. 1.2 and 1.3 show part of the metre rule drawn actual size.

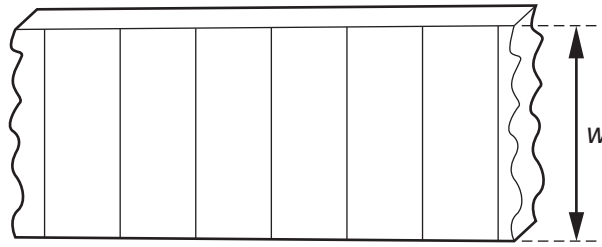


Fig. 1.2

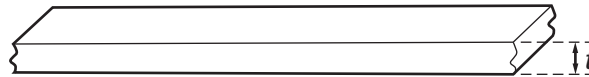


Fig. 1.3

(i) Take and record measurements from Fig. 1.2 to determine the average width  $w$  of the metre rule.

$w = \dots\dots\dots$  cm

(ii) Take and record measurements from Fig. 1.3 to determine the average thickness  $t$  of the metre rule.

$t = \dots\dots\dots$  cm

(iii) Calculate the volume  $V$  of the metre rule using the equation  $V = lwt$  where  $l$  is the length of the metre rule (100.0 cm).

$V = \dots\dots\dots$  [3]

(iv) Calculate the density  $\rho$  of the metre rule using the equation  $\rho = \frac{m}{V}$ .

$\rho = \dots\dots\dots$  [3]

(d) State the assumption that the student has made about the position of the centre of mass of the metre rule.

$\dots\dots\dots$  [1]

[Total: 10]

- 4 An IGCSE student is investigating moments using a simple balancing experiment. He uses a pivot on a bench as shown in Fig. 5.1.

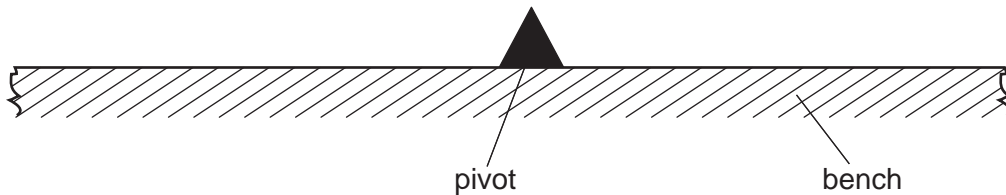


Fig. 5.1

First, the student balances the metre rule, without loads, on the pivot. He finds that it does not balance at the 50.0 cm mark, as he expects, but it balances at the 49.7 cm mark.

Load **Q** is a metal cylinder with diameter a little larger than the width of the metre rule, so that it covers the markings on the rule. Load **Q** is placed carefully on the balanced metre rule with its centre at the 84.2 cm mark. The rule does not slip on the pivot.

- (a) Draw on Fig. 5.1 the metre rule with load **Q** on it. [2]
- (b) Explain, using a labelled diagram, how the student would ensure that the metre rule reading at the centre of **Q** is 84.2 cm.

[2]

- (c) Calculate the distance between the pivot and the centre of load **Q**.

distance = ..... [1]  
 [Total: 5]



- 5 An IGCSE student is determining the density of a solid metal cylinder using a balancing method. Fig. 1.1. shows the apparatus.

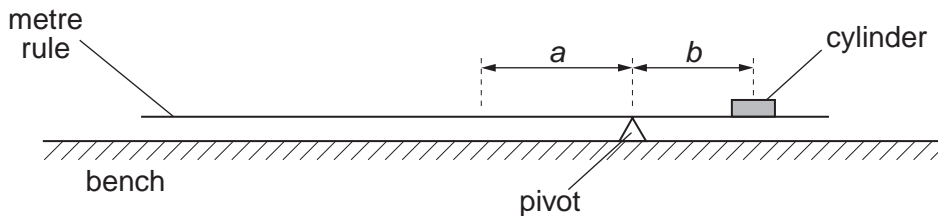


Fig. 1.1

He places the cylinder on the metre rule so that its centre is directly above the 10.0 cm mark. The rule is placed on the pivot so that the rule is as near as possible to being balanced.

He measures and records the distance  $a$  from the centre of the rule to the pivot and the distance  $b$  from the centre of the cylinder to the pivot. He repeats the experiment with the same cylinder at different positions on the rule.

The readings are shown in Table 1.1.

Table 1.1

| $a/$ | $b/$ | $M/$ |
|------|------|------|
| 12.6 | 27.4 |      |
| 11.0 | 24.0 |      |
| 9.5  | 20.5 |      |

- (a) (i) Complete the column headings in Table 1.1.  
 (ii) For each set of readings, calculate the mass  $M$  of the cylinder using the equation

$$M = \frac{ka}{b}.$$

The value of  $k$  is the mass of the rule which is 108 g.

Enter the results in Table 1.1.

- (b) The cylinder completely covers the marks on the metre rule. Describe, with the aid of a diagram, how you would judge that the centre of the cylinder is directly above the 10.0cm mark.

.....  
..... [1]

- (c) Use your answers in Table 1.1 to calculate and record the average of the three values for  $M$ . Show your working.

average value for  $M$  = ..... [2]

(d) Fig. 1.2 shows the cylinder placed flat on the bench and viewed from one side.

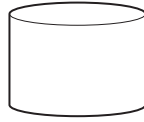


Fig. 1.2

(i) On the diagram, measure the diameter  $d$  and the thickness  $t$  of the cylinder.

$d =$  .....

$t =$  .....

(ii) Calculate the volume  $V$  of the cylinder using the equation

$$V = \frac{\pi d^2 t}{4}.$$

$V =$  .....

(iii) Calculate the density  $\rho$  of the cylinder using the equation

$$\rho = \frac{M}{V}.$$

$\rho =$  ..... [3]

[Total: 9]

- 6 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.

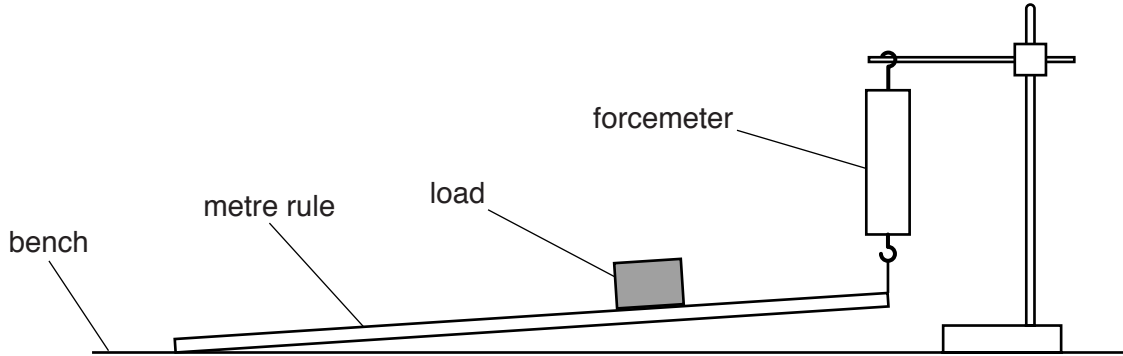


Fig. 2.1

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

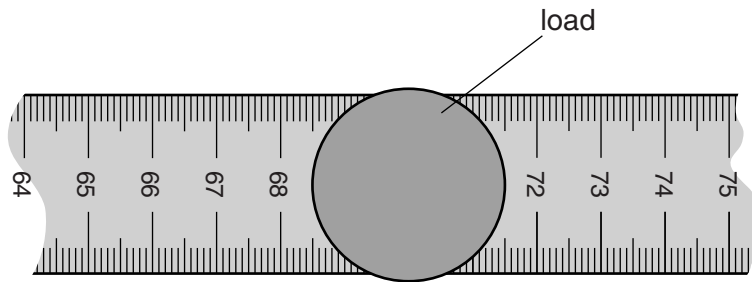


Fig. 2.2 (not full size)

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  $L = 1.00\text{ N}$ ,  $2.00\text{ N}$ ,  $3.00\text{ N}$ ,  $4.00\text{ N}$  and  $5.00\text{ N}$ .

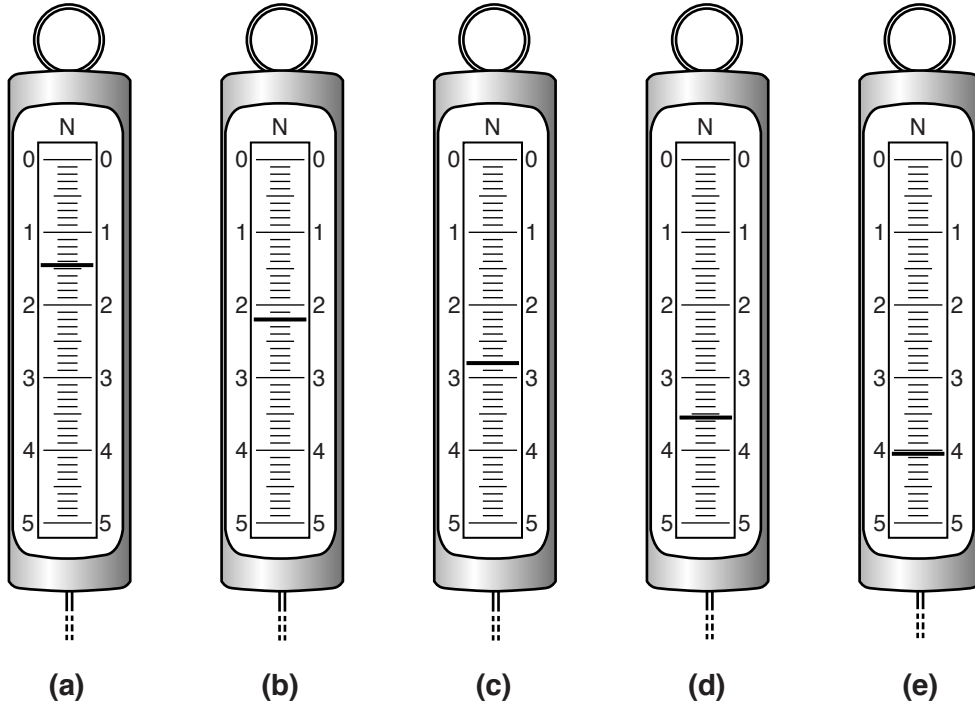


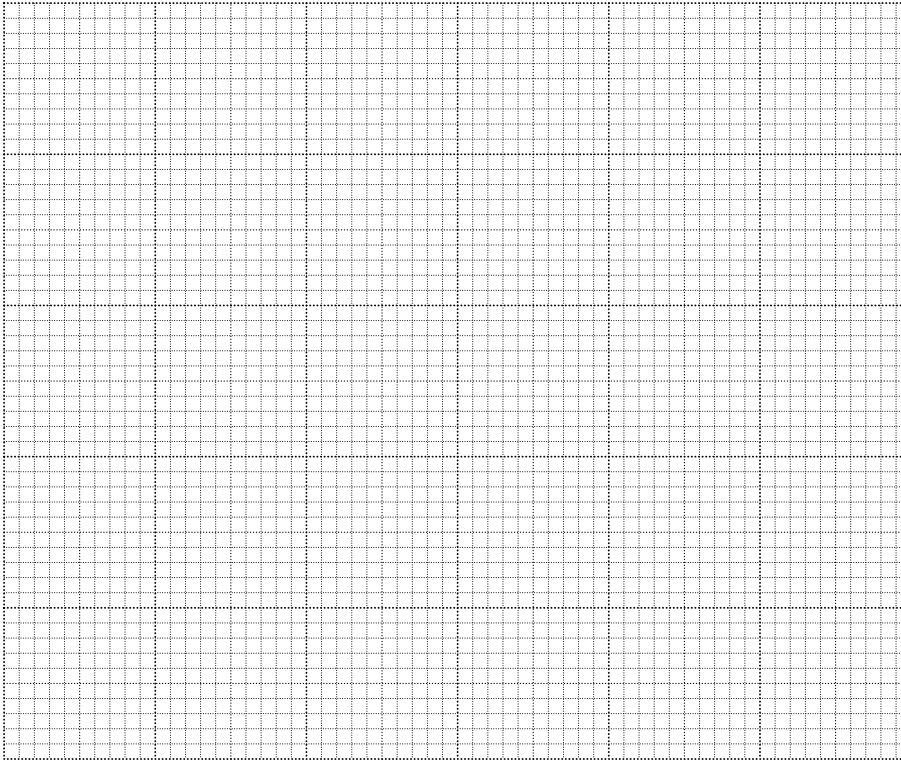
Fig. 2.3

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

Table 2.1

| $L/\text{N}$ | $F/\text{N}$ |
|--------------|--------------|
| 1.00         |              |
| 2.00         |              |
| 3.00         |              |
| 4.00         |              |
| 5.00         |              |

(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.

$y = \dots\dots\dots$ [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.

$W = \dots\dots\dots$ [2]

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

.....  
.....  
.....[1]

[Total: 12]