# Moments/Centre of Mass

## Question Paper 3

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|---|---|
| **Level** | IGCSE |
| **Subject** | Physics |
| **Exam Board** | CIE |
| **Topic** | General Physics |
| **Sub-Topic** | Moments/ Centre of Mass |
| **Paper Type** | Alternative to Practical |
| **Booklet** | Question Paper 3 |

**Time Allowed:** **53 minutes**

**Score:** **/44**

**Percentage:** **/100**

**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.

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.................................................................................................................................... [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.

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.................................................................................................................................... [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.

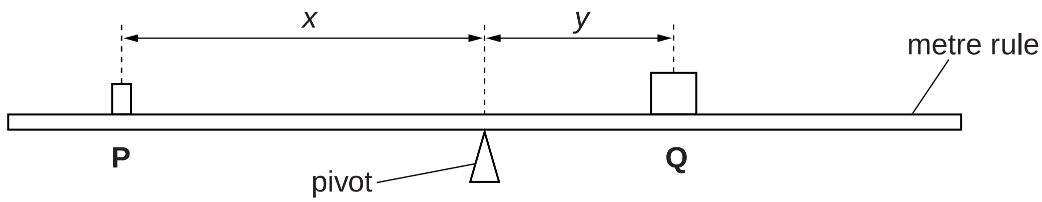


**Fig. 1.1**

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.

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[Total: 5]

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

Fig. 1.1 shows the apparatus.

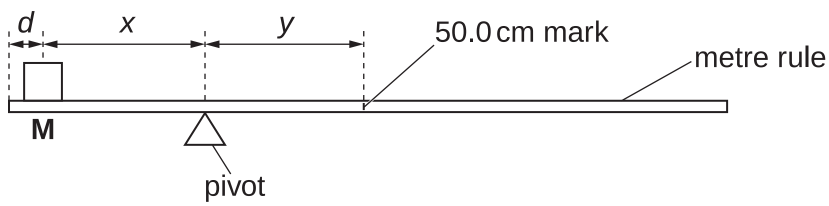


**Fig. 1.1**

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.

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**(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.

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.................................................................................................................... [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.

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.................................................................................................................... [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.

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[Total: 6]

**3** An IGCSE student is determining the position of the centre of mass of a triangular card.

The apparatus is shown in Fig. 1.1.

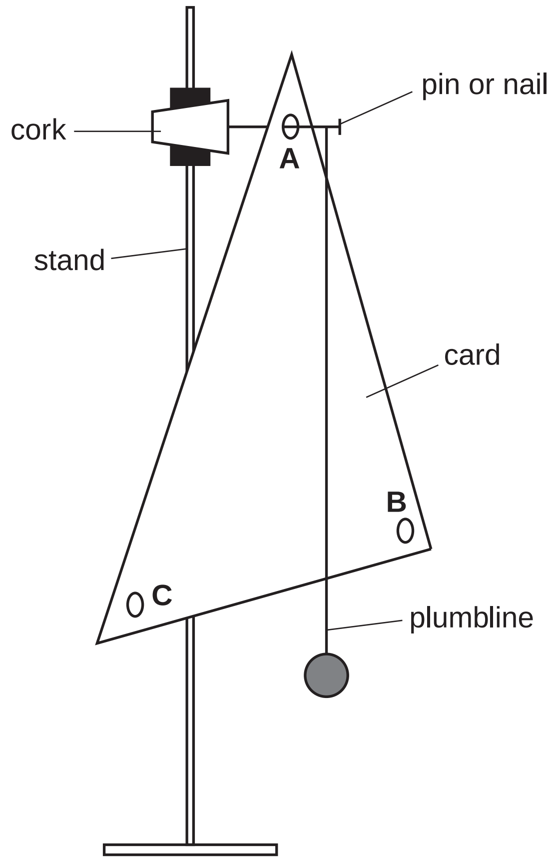


**Fig. 1.1**

**(a)** The student hangs the card on the nail through hole **A**. He checks that the card is able to swing freely and then hangs the plumbline from the nail so that it is close to, but not touching, the card. When the card and plumbline are still, he makes a small mark at the edge of the card where the plumbline crosses the edge. He removes the card and draws a line from the mark to hole **A**.

He repeats the procedure using holes **B** and **C**.

Fig.1.2 is a drawing of the card.

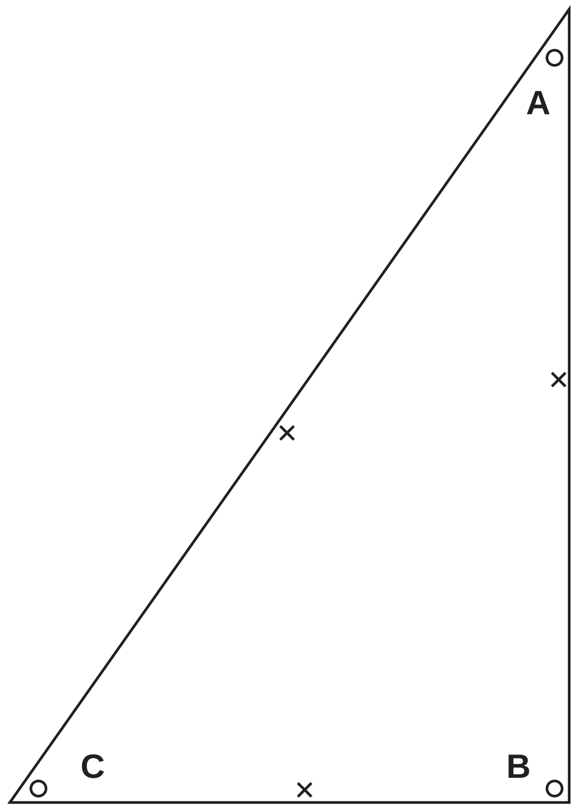


**Fig.1.2**

On Fig.1.2, the position of each of the marks the student makes is shown with a small cross. On Fig. 1.2, draw in the lines between the positions of the holes **A**, **B** and **C** and the corresponding crosses on the card. [2]

**(b)** If the experiment is completely accurate, the centre of mass of the card is at the position where the three lines meet. On Fig. 1.2, judge the best position for the centre of mass, marking it with a small cross. Draw a line from this position to the right-angled corner of the card and measure the distance *a* between the centre of mass and the right-angled corner of the card.

*a* = .......................................[3]

**(c)** In this experiment, it is important that the card is able to swing freely. For this reason, the plumbline should not touch the card but be a small distance from it. This could cause an inaccuracy in marking the card at the correct position. Describe how you would minimise this possible inaccuracy. You may draw a diagram.

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

[Total: 6]

**4** The IGCSE class is investigating the loading of a metre rule.

Fig. 1.1 shows the apparatus.

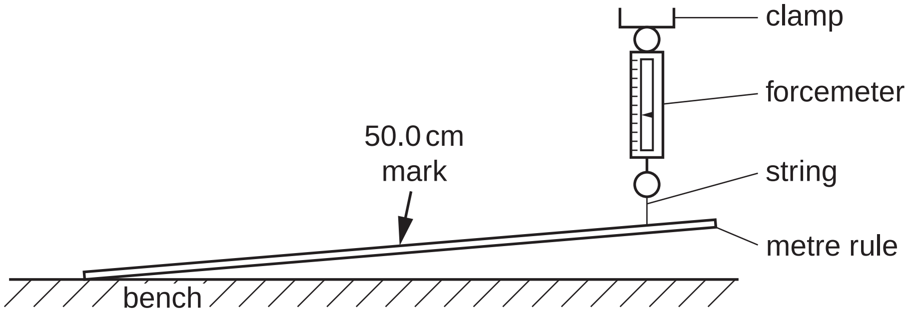



**Fig. 1.1**

**(a)** A metre rule is attached at one end to the bench. The other end is supported by a forcemeter.

A student records in Table 1.1 the reading *F* on the forcemeter.

He places a 100 g mass on the rule at the 50.0 cm mark and records in the table the value of the reading *F* on the forcemeter. He repeats the procedure using masses of 200 g, 300 g, 400 g and 500 g. The forcemeter readings are shown in the table.

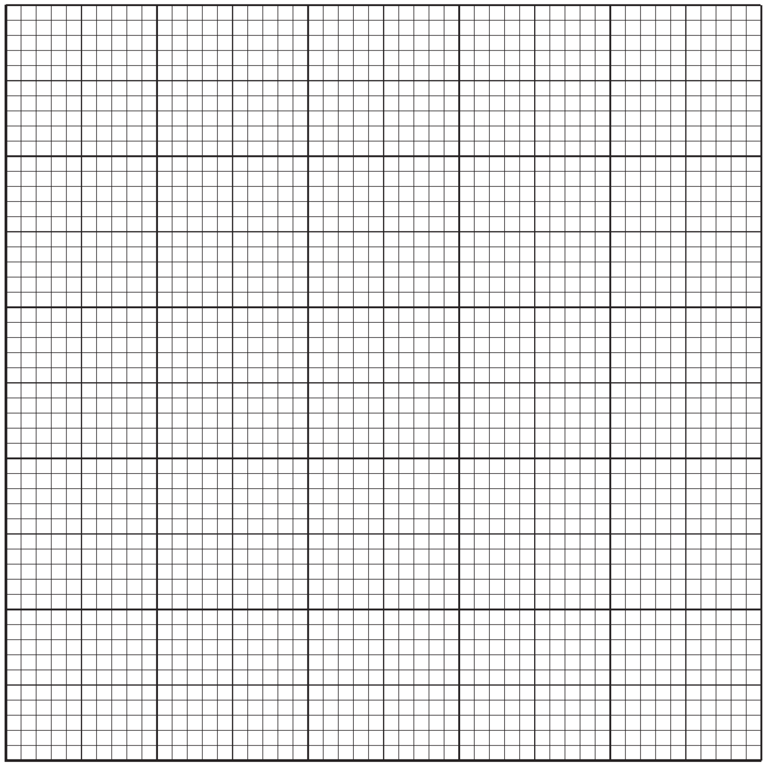
Write the mass values in the table.

**Table 1.1**

| *m* / g | *F* / N |
|---|---|
| 0 | 1.10 |
| | 1.85 |
| | 2.20 |
| | 2.95 |
| | 3.50 |
| | 4.20 |

[1]

**(b)** Plot a graph of *F*/N (*y*-axis) against *m*/g (*x*-axis).



[5]

**(c)** Use the graph to find the value of *F* when *m* = 375 g. Show clearly on the graph how you obtained the result.

*F* = ........................................[2]

**(d)** The forcemeter shows a reading when no mass has been added to the metre rule. Assuming that the forcemeter has no zero error, suggest a reason for the reading.

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[Total: 9]

**5** An IGCSE student is determining the weight of a metre rule.

Fig. 1.1 shows the apparatus.

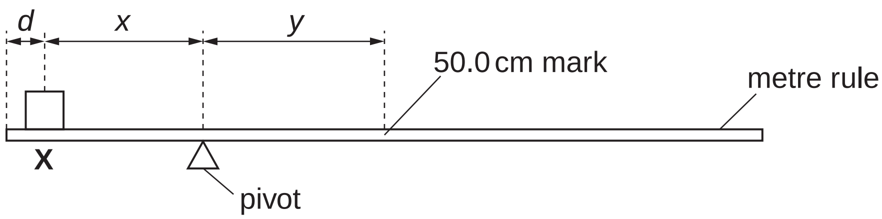


**Fig. 1.1**

**X** is a 1.0 N load.

The student places the load **X** on the rule so that its centre is at *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, with the 50.0 cm mark to the right of the pivot.

He measures and records the distance *x* from the centre of the load **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* values of 10.0 cm, 15.0 cm, 20.0 cm and 25.0 cm. The readings of *d*, *x* and *y* are shown in Table 1.1.

**Table 1.1**

| *d* / cm | *x* / cm | *y* / cm |
|---|---|---|
| 5.0 | 23.7 | 21.3 |
| 10.0 | 21.0 | 19.1 |
| 15.0 | 18.5 | 16.3 |
| 20.0 | 16.0 | 14.1 |
| 25.0 | 13.9 | 12.0 |

**(a)** Plot the graph of $y$ / cm ($y$-axis) against $x$ / cm ($x$-axis). You do not need to include the origin (0,0) on your graph.

[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 $W$ of the metre rule using the equation $W = \frac{L}{G}$, where $L$ = 1.0 N.

$W$ = .......................................................... [1]

**(d)** The calculation of *W* is based on the assumption that the centre of mass of the rule is at the 50.0 cm mark.

**(i)** Describe briefly how you would determine the position of the centre of mass of the rule.

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**(ii)** Describe how you would modify the experiment if the centre of mass was at the 49.7 cm mark.

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..........................................................................................................................................[2]

[Total: 9]

**6** The IGCSE class is investigating the law of moments.

Fig. 1.1 shows the apparatus used.

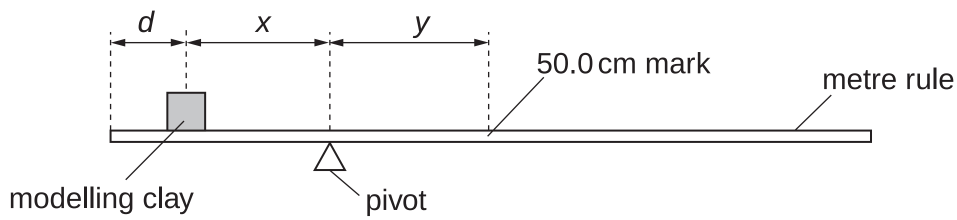


**Fig. 1.1**

**(a)** A student moulds a piece of modelling clay into a cube shape. He places the modelling clay on the rule so that its centre is a distance $d$ = 10.0 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, with the 50.0 cm mark to the right of the pivot.

**(i)** On Fig.1.1, measure the distance $x$ from the centre of the modelling clay to the pivot.

$x$ = ..............................................................

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

$y$ = ..............................................................
[1]

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

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

$X$ = ..............................................................

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

$Y$ = ..............................................................

**(iii)** Calculate the mass $m_1$ of the piece of modelling clay using the equation

$$m_1 = \frac{MY}{X}$$

where the mass of the metre rule $M$ = 112 g.

$m_1$ = ..............................................................
[4]

**(c)** The student cuts the piece of modelling clay into two pieces, with one piece approximately twice the size of the other piece.

Using the larger piece of modelling clay, he repeats the procedure and obtains a result for the mass $m_2$ of 64.9 g.

Using the smaller piece of modelling clay, he repeats the procedure and obtains a result for the mass $m_3$ of 34.5 g.

Calculate $(m_2 + m_3)$.

$(m_2 + m_3)$ = ........................................................ [1]

**(d)** Assuming that the experiment has been carried out with care, suggest two reasons why $(m_2 + m_3)$ may not be equal to $m_1$.

1. ..............................................................................................................................

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2. ..............................................................................................................................

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**(e)** Explain briefly how you would ensure that the centre of the cube of modelling clay is at the 10.0 cm mark on the metre rule. You may draw a diagram.

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

[Total: 9]