INVESTIGATING PRINCIP,E OF MOMENTS

1 The IGCSE class is investigating the law of moments.
Fig. 1.1 shows the apparatus used.

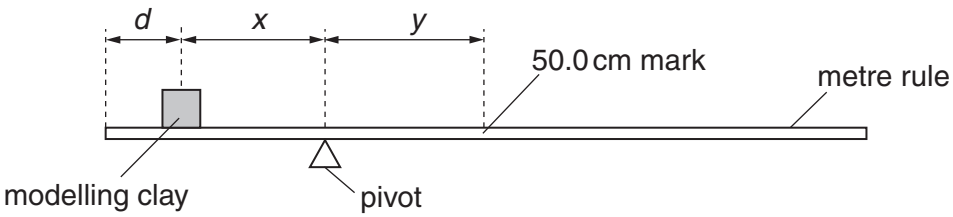


Fig. 1.1

(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. .....

.....

2. .....

.....[2]

(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.

.....

.....

.....[1]

[Total: 9]

(a) x = 1.9 (cm), 19 (mm) 0.019 (m), y = 2.1 (cm), 21 (mm), 0.021 (m) [1]

(b) unit in **(a)** seen at least once and correct, matching both figures [1]
evidence of x and y values from **(a)** × 10 [1]
m_1 = 124 OR 0.124 accept more sig. figs. [1]
unit seen, g or kg to match figures [1]

(c) $m_2 + m_3$ = 99.4 (g) [1]

(d) two from:
modelling clay remaining on knife/rule/fingers/lost in cutting
more difficult to balance with smaller pieces
more readings so more inaccuracies
rounding errors in extra calculations
difficult to find centre of misshapen cube
modelling clay might not have uniform density [2]

(e) mark centre of bottom of cube OR take readings at either side of cube [1]

[Total: 9]

2 A student carried out a 'principle of moments' experiment using a metre rule placed on a pivot at the 50.0 cm mark. The aim was to determine an unknown weight. The arrangement of the apparatus is shown in Fig. 3.1.

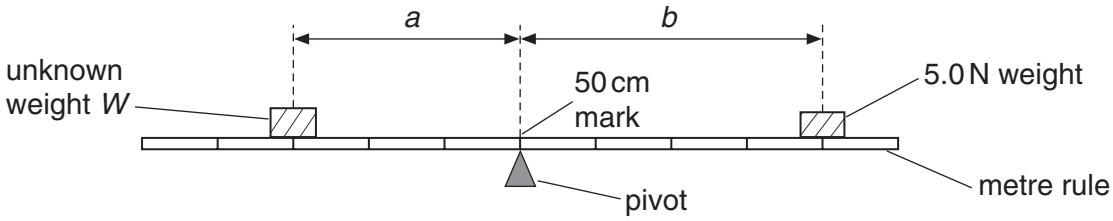


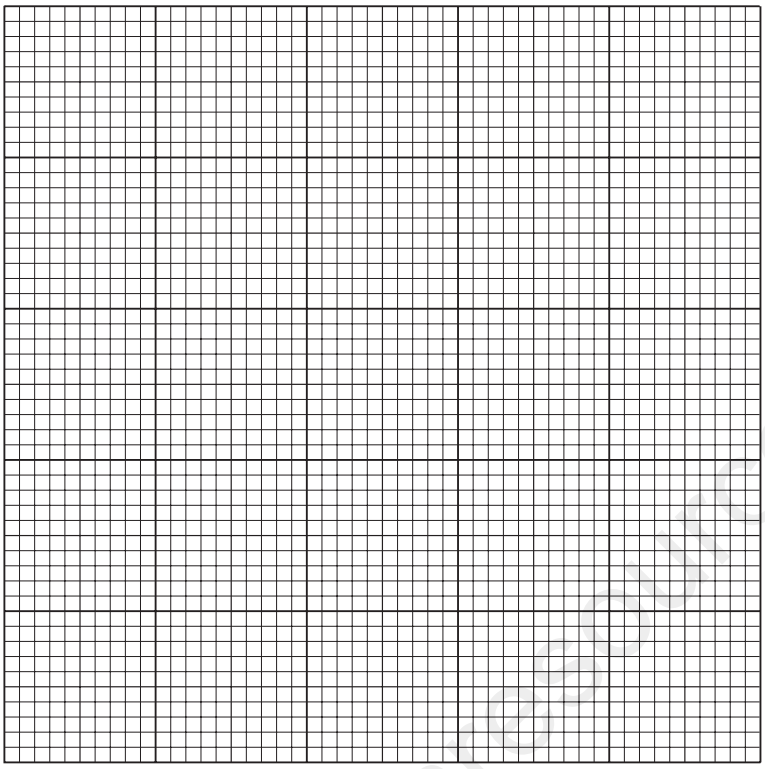
Fig. 3.1

The student placed the unknown weight *W* at a convenient distance *a* from the pivot. He found *b*, the distance from the pivot that the 5.0 N weight must be placed so that the rule balanced horizontally. He then repeated the experiment using different values of *a*.
The readings are shown in the table below.

a/m	*b*/m
0.100	0.122
0.200	0.238
0.250	0.302
0.300	0.360
0.350	0.435
0.400	0.470

(a) **(i)** Plot the graph of b/m (y-axis) against a/m (x-axis).

(ii) Draw the best-fit straight line.



[6]

(iii) Determine G, the gradient of the line.

G = ...

(iv) Determine W, the unknown weight, using the equation

$$W = XG$$

where X = 5.0 N.

W = ...

(v) Explain why the student could not choose distance *a* to have a value of 0.450 m.

.....

.....[5]

(b) Another student, who was performing this experiment, found that the unloaded metre rule balanced on the pivot at the 50.3 cm mark, instead of the 50.0 cm mark.
Suggest what the student should do to obtain the correct value for *W* from the experiment.

.....

.....[1]

3. (a) (i) & (ii) scales	1
labels	1
plots (-1 each error)	2
line judgement –str line thin & neat & good plots	1
- best fit	1
(iii) large triangle (> ½ line) seen	1
G = 1.15 – 1.25	1
(iv) correct value (ecf) (= 6.0)	1
unit & 2/3 sf	1
(v) weight off end of rule	1
(b) add plasticine to end or balance at 50.3 cm and take measurements accordingly OR move pivot to 50.3 mark OR no action – result will still be correct	1
	TOTAL 12

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

Fig. 1.1 shows the apparatus.

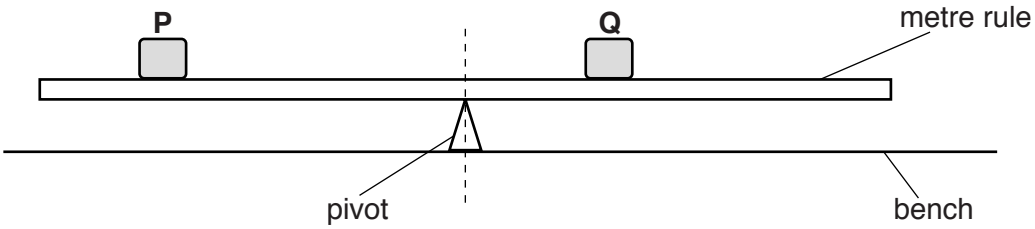


Fig. 1.1

(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.

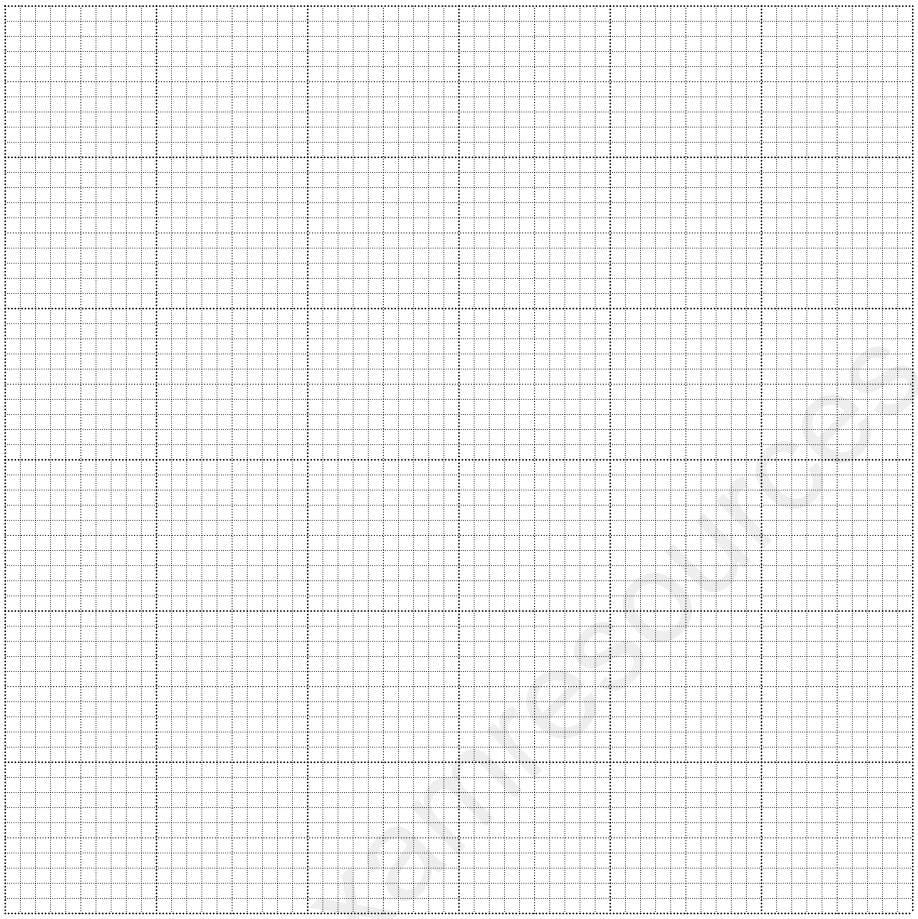
Calculate the actual distance *a* from the centre of load **P** to the pivot. Calculate the actual distance *b* from the pivot to the centre of load **Q**. Write the results in Table 1.1. [1]

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]

(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]