INVESTIGATING PRINCIPLE OF MOMENTS

1 The class is investigating the principle of moments

Fig. 4.1 shows the apparatus used.

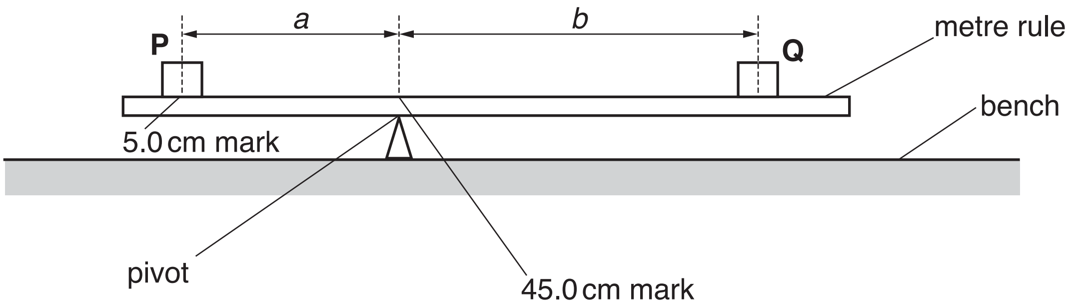

Fig. 4.1

(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]

MARKING SCHEME

(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 rot at the centre (of mass) of the rule	1
	Total:	**8**

2 A student investigates the balancing of a metre rule.

Fig. 1.1 shows the arrangement.

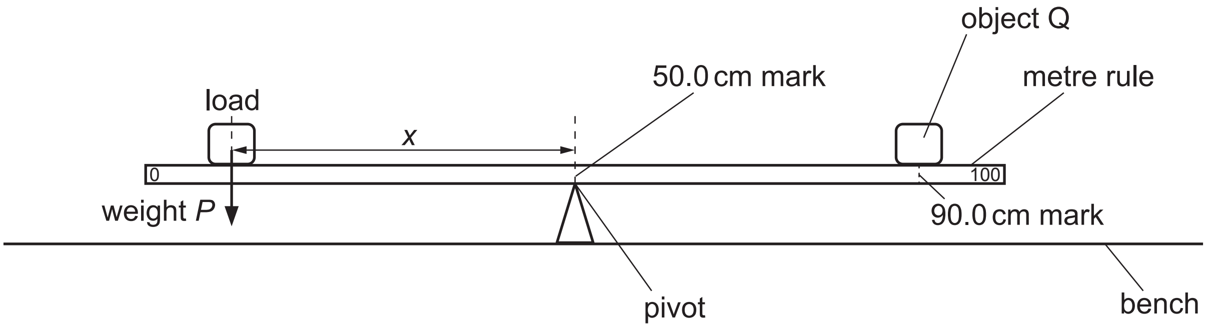

Fig. 1.1

(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.

....

....

.... [1]

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

....

....

.... [1]

[Total: 11]

MARKING SCHEME

1(a)	0.025, 0.037, 0.050, 0.063, 0.075	**1**
	Consistent significant figures	**1**
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**
1(c)	(0.02) Method shown clearly on graph	**1**
	Value correct to $\frac{1}{2}$ small square	**1**
1(d)	Clear wording or diagram	**1**
1(e)(i)	Difficult to obtain balance point	**1**
1(e)(ii)	Idea of obtaining nearest to balance	**1**