INVESTIGATING MOMENTS

1 A student is investigating moments using a balancing method.

Fig. 1.1 shows the apparatus.

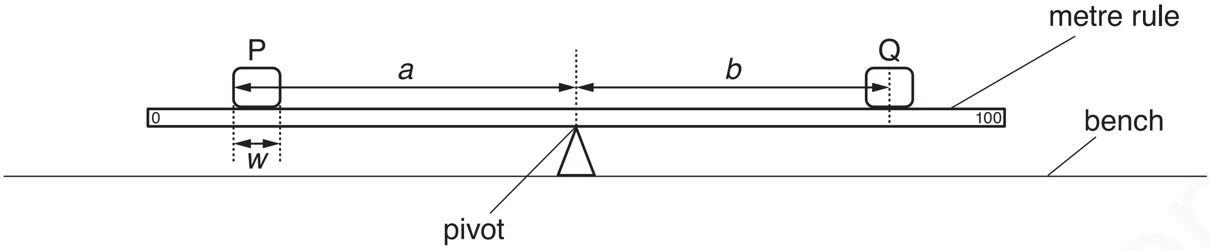


Fig. 1.1

(a) The student places the metre rule, without the loads, on the pivot and adjusts its position so that the metre rule is as near as possible to being balanced. She keeps the rule at this position on the pivot throughout the experiment.

Explain briefly why this position on the pivot may not be exactly at the 50.0 cm mark of the rule.

....

.... [1]

(b) She places a load P on the metre rule so that the **edge** that is furthest from the pivot is exactly at the 10.0 cm mark on the rule.

She measures the distance *a* between this **edge** of the load P and the pivot, as shown in Fig. 1.1.

She places a load Q on the metre rule and adjusts the position of load Q so that the metre rule is as near as possible to being balanced.

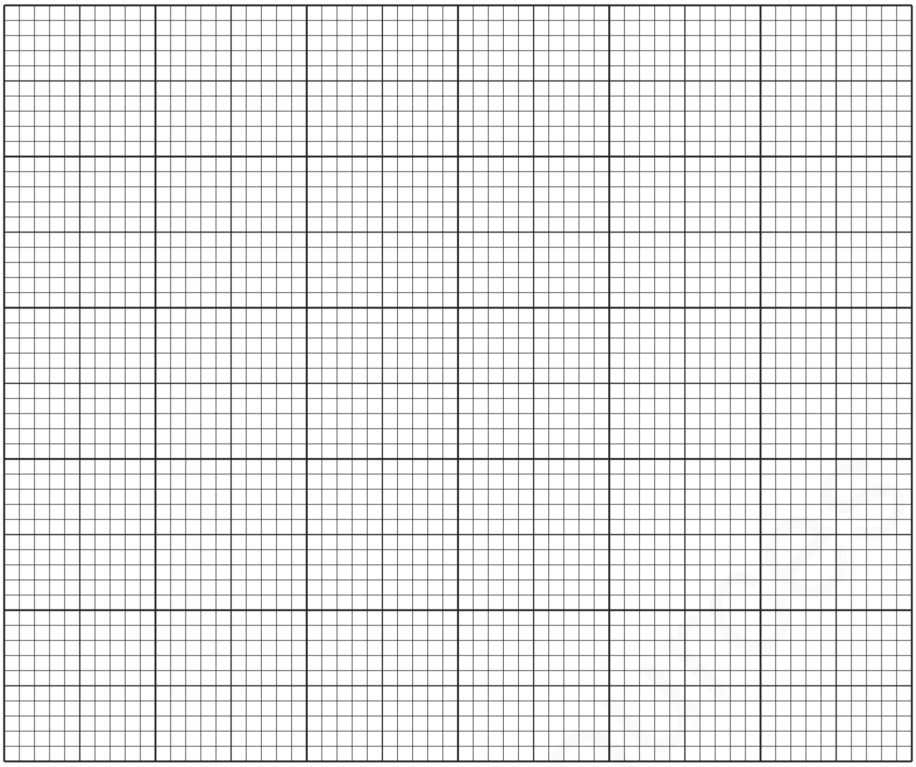
She measures the distance *b* between the **centre** of load Q and the pivot, as shown in Fig. 1.1.

She repeats the procedure, with the **edge** of the load P that is furthest from the pivot at the 15.0 cm, 20.0 cm, 25.0 cm and 30.0 cm marks. All the readings are shown in Table 1.1.

Table 1.1

a / cm	*b* / cm
38.0	44.5
33.0	38.5
28.0	33.6
23.0	27.2
18.0	22.0

Plot a graph of a/cm (y-axis) against b/cm (x-axis). Start both axes at the origin (0,0).



[4]

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

G = ... [2]

(d) Determine the intercept C on the x-axis of the graph. This is the value of b when a = 0.

C = ... [1]

(e) On Fig. 1.2, measure the width w of the load P.

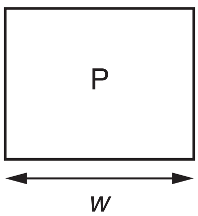


Fig. 1.2

w = ... [1]

(f) Another student suggests that the value of the intercept C should be equal to half the width w of the load P. State whether the results support the suggestion. Justify your answer by reference to the results.

statement ....

justification ....

.... [2]

(g) Suggest **one** practical reason why it is difficult to obtain accurate values for a and for b.

....

.... [1]

[Total: 12]

MARKING SCHEME

(a)	centre of mass/gravity not in centre (however expressed)	1
(b)	graph:	
	axes correctly labelled and right way round	1
	suitable scales starting from (0,0)	1
	all plots correct to less than ½ small square	1
	good line judgement, thin, continuous line	1
(c)	triangle method used and <u>seen on graph</u>	1
	triangle at least half of distance between extreme plotted points i.e. $\Delta a \geqslant 10$	1
(d)	intercept correct to ½ small square – if graph not extrapolated, use the ruler tool	1
(e)	width 2.5(0) cm / 25 mm with correct unit	1
(f)	statement to match results	1
	justification to match statement and include idea of within (or beyond) limits of experimental accuracy	1
(g)	difficulty in achieving exact balance/keeping the pivot in the same position/locating the centre of load (Q)/load(s) slipping/load obscuring readings on rule	1

2 A student is determining the weight of a load using a balancing method.

Fig. 1.1 shows the apparatus. It is not drawn to scale.

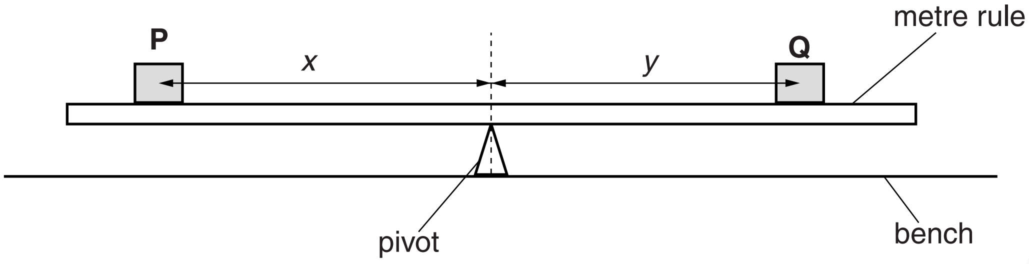


Fig. 1.1 (not to scale)

(a) The student places the metre rule on the pivot and adjusts its position so that the metre rule is as near as possible to being balanced. He records the scale reading of the metre rule at the point where the rule balances on the pivot.

scale reading = ...50.2 cm........

He places a 2.00 N load **P** on the metre rule so that its centre is exactly at the 20.0 cm mark on the rule.

(i) Use this information to determine the distance *x*.

x = ... cm [1]

(ii) Explain how you would ensure that the centre of the load **P** is exactly at the 20.0 cm mark on the rule. You may draw a diagram.

....

....

....

....[2]

(b) The student places a load **Q** on the metre rule and adjusts its position so that the metre rule is as near as possible to being balanced.

He measures the distance y between the centre of load **Q** and the pivot.

y = ...15.3 cm............

Calculate the weight W of load **Q** using the equation $W = \frac{kx}{y}$, where k = 2.00 N.

W = ...[1]

(c) The student repeats the procedure using a different, suitably chosen, distance x.

Suggest a suitable distance x.

x = ...cm [1]

(d) The student calculates a new value of W.

W = ...4.04 N............

Suggest two reasons why the values determined for W may not be the same.

1. ....

2. ....

[2]

(e) Calculate the average W_{AV} of the values for W, the weight of load **Q**. Give your answer to a suitable number of significant figures for this experiment.

W_{AV} = ...N [2]

[Total: 9]

MARKING SCHEME

1(a)(i)	x = 30.2(cm)	**1**
1(a)(ii)	Measure width w of load Place w / 2 either side of desired position OR draw centre line on load / find centre (of mass) of load and mark **side** of rule in desired position OR take readings on both sides of the load and find the mean	**1** **1**
1(b)	W = 3.95 (N)	**1**
1(c)	new x at least 5 cm different from original and in the range 10 cm–45 cm	**1**
1(d)	**two** from: difficult to judge the best position of 'almost balanced' is the centre of mass of the ruler exactly over the pivot / has the ruler slipped on the pivot? the load(s) obscure the scale the position of the centre of the load(s) is difficult to judge	**2**
1(e)	3.995 or 4 seen 2 or 3 significant figures (whatever the answer)	**1** **1**
	Total:	**9**

3 A student is determining the weight of a load using a balancing method.

Fig. 4.1 shows the apparatus used.

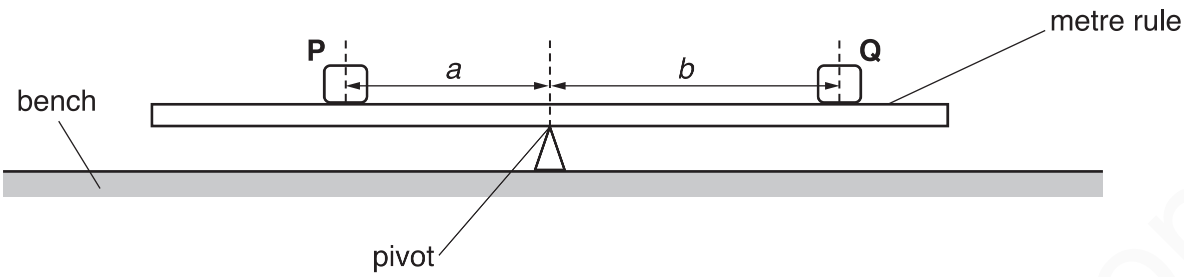


Fig. 4.1

The student places the metre rule on the pivot and adjusts its position so that the metre rule is as near as possible to being balanced.

He places a load **P** on the metre rule so that its centre is exactly at the 30.0 cm mark.

He records the distance *a* between **P** and the pivot.

a = 19.8 cm

He places a load **Q** of weight Q = 1.0 N on the metre rule and adjusts the position of **Q** so that the metre rule is as near as possible to being balanced.

He measures the distance *b* between the centre of load **Q** and the pivot.

He repeats the procedure, with the load **P** remaining at the 30.0 cm mark, using Q values of 2.0 N, 3.0 N, 4.0 N and 5.0 N. All the readings are recorded in Table 4.1.

Table 4.1

Q/N	b/cm	$\frac{1}{Q}/\frac{1}{N}$
1.0	40.0	
2.0	19.5	
3.0	13.5	
4.0	10.5	
5.0	7.5	

(a) For each value of Q, calculate $\frac{1}{Q}$ and record the result in the table. [1]

(b) Plot a graph of b/cm (y-axis) against $\frac{1}{Q} \Big/ \frac{1}{N}$ (x-axis).

[4]

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

G = ...[2]

(ii) Calculate the weight P of load **P** using the equation $P = \frac{G}{a}$, where a = 19.8 cm.

P = ...[1]

(d) The student measures the weight *P* of load **P** using a forcemeter. Fig. 4.2 shows the forcemeter.

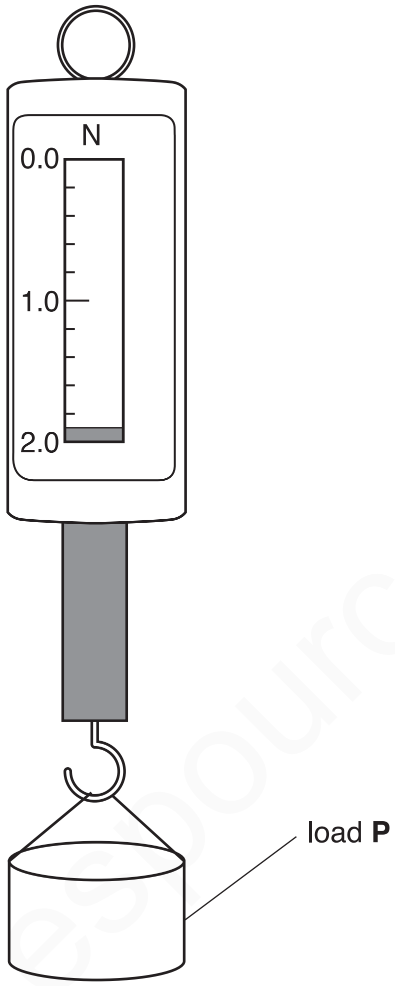


Fig. 4.2

Write down the reading *P* shown on the forcemeter.

P = ... N [1]

(e) The student has carried out the experiment with care and is expecting the two values of *P* in **(c)** and **(d)** to be the same.

Suggest **two** reasons why the values of *P* may be different.

1. ....

....

2. ....

....
[2]

[Total: 11]

4(a)	$1/Q$ values 1.(0), 0.5(0), 0.33(3), 0.25, 0.2(0)	1
4(b)	Graph:	
	Axes correctly labelled and right way round	1
	Suitable scales	1
	All 5 plots correct to ½ small square	1
	Good line judgement, thin, continuous line	1
4(c)(i),(ii)	At least half line used for triangle method	1
	Clearly shown on graph	1
	P = 1.8 – 2.2 (N)	1
4(d)	1.9	1
4(e)	Two from: Difficulty in obtaining balance Difficulty in judging centre of loads Loads may slip / slide Forcemeter not sensitive Forcemeter zero error	2

4 A student determines the weight of a metre rule using a balancing method.

Fig. 1.1. shows the apparatus.

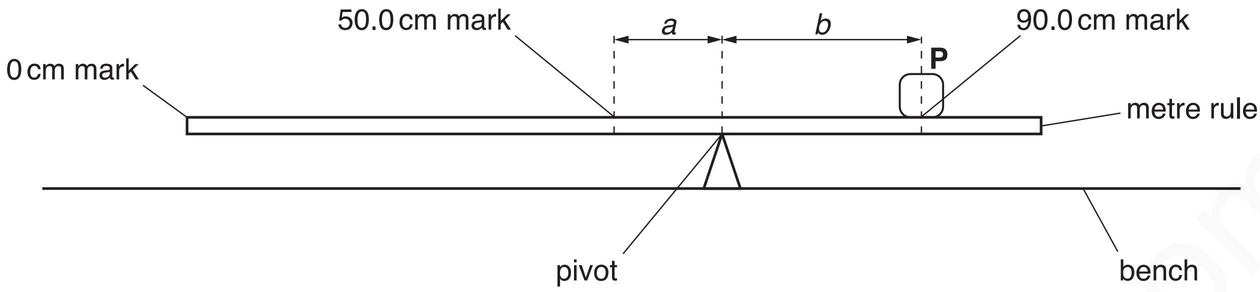


Fig. 1.1

(a)
- The student places the metre rule on the pivot.
- He places the load **P**, labelled **1.5 N**, on the metre rule at the 90.0 cm mark.
- Keeping **P** at the 90.0 cm mark, he adjusts the position of the metre rule on the pivot so that the metre rule is as near as possible to being balanced.
- In Table 1.1, he records the distance *a* from the 50.0 cm mark to the pivot.

(i) Calculate, and record in Table 1.1, the distance *b* between the centre of load **P** and the pivot. [1]

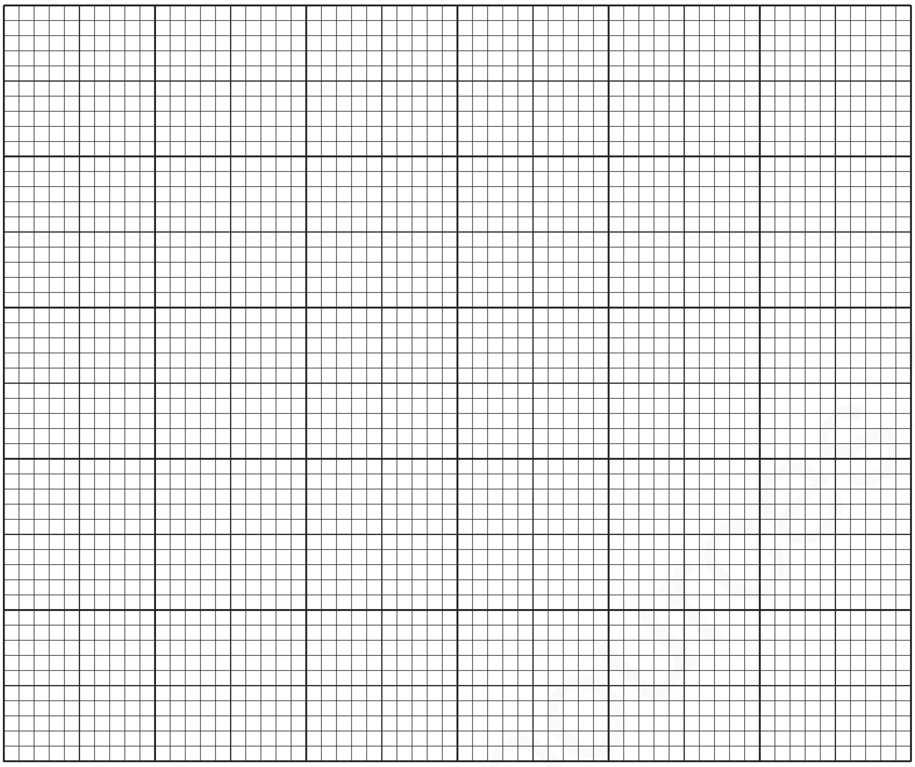
(ii) Calculate $\frac{a}{b}$. Record its value in Table 1.1. [1]

(b) The student repeats the procedure using loads of 1.2 N, 1.0 N, 0.8 N and 0.5 N. The readings and results are shown in Table 1.1.

Table 1.1

Weight of load, **P** / N	a / cm	b / cm	$\frac{a}{b}$
1.5	23.1		
1.2	21.2	18.8	1.13
1.0	18.9	21.1	0.900
0.8	16.8	23.2	0.724
0.5	12.5	27.5	0.455

Plot a graph of weight of load **P** / N (y-axis) against $\frac{a}{b}$ (x-axis). You do **not** need to begin your axes at the origin, (0,0).



[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 numerically equal to the weight W of the metre rule. Write down the value of W to an appropriate number of significant figures for this experiment. Include the unit.

W = ... [2]

(e) The student has assumed that the centre of mass of the metre rule is at the 50.0 cm mark. Explain briefly how you would find as accurately as possible the position of the centre of mass of the metre rule. No extra apparatus or materials are available.

....

....

.... [1]

(f) Briefly state the main difficulty that you would have when carrying out this type of balancing experiment.

....

.... [1]

[Total: 12]

MARKING SCHEME

1(a)(i)	*b* 16.9	**1**
1(a)(i)	*a* / *b* 1.37 (ecf allowed)	**1**
1(b)	Graph:	
	Axes correctly labelled and right way round	**1**
	Suitable scales	**1**
	All plots correct to ½ small square	**1**
	Good line judgement, thin, continuous line	**1**
1(c)	triangle method indicated on graph	**1**
	triangle at least half of candidate's distance between extreme plots	**1**
1(d)	Correct calculation, $W = G$	**1**
	to 2 or 3 significant figures	**1**
1(e)	Balance on pivot with no load – balance point is at c of m	**1**
1(f)	Obtaining a stable balance	**1**