WEIGHT-METER RULE

1 The IGCSE class is determining the weight of a metre rule.
The apparatus is shown in Fig. 5.1.

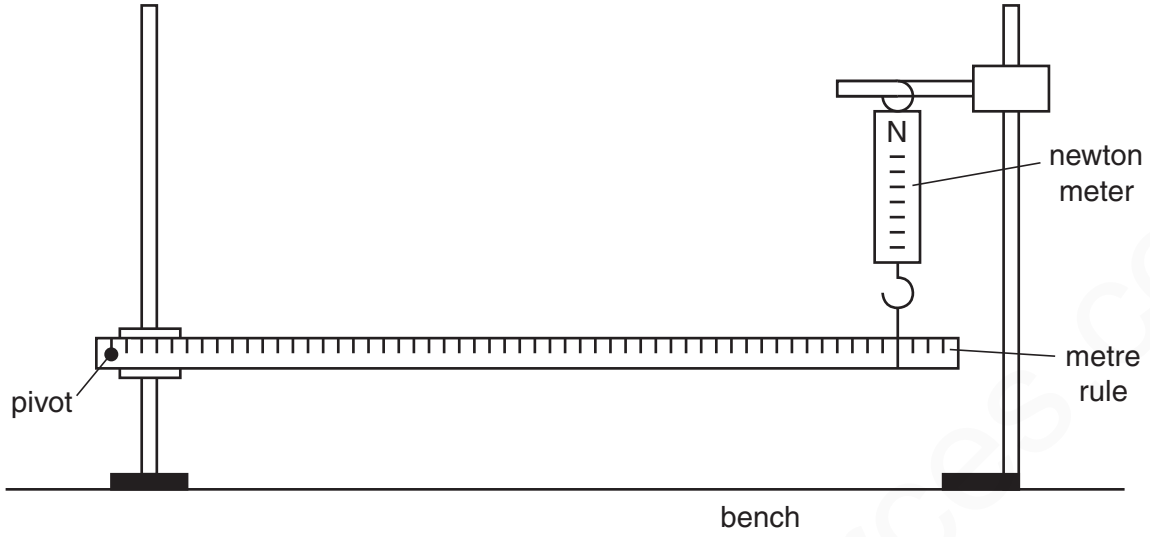


Fig. 5.1

A metre rule is supported at one end by a pivot through the 1.0 cm mark. The other end is supported at the 91.0 cm mark by a newton meter hanging from a clamp.

(a) Describe how you would check that the metre rule is horizontal. You may draw a diagram if you wish.

.....

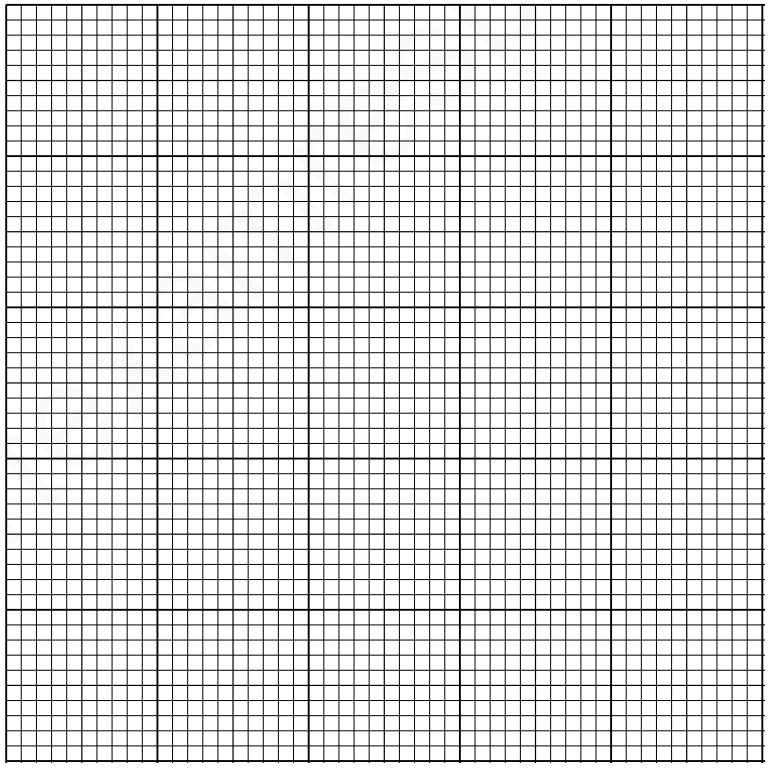
..... [1]

(b) The students record the force F shown on the newton meter and the distance d from the pivot to the 91 cm mark. They then repeat the experiment several times using a range of values of the distance d. The readings are shown in the table.

F/N	d/m	$\frac{1}{d} \,/\, \frac{1}{m}$
0.74	0.900	
0.78	0.850	
0.81	0.800	
0.86	0.750	
0.92	0.700	

Calculate and record in the table the values of $\frac{1}{d}$. [1]

(c) **(i)** On the graph grid below, plot a graph of F/N (y-axis) against $\frac{1}{d} \,/\, \frac{1}{\text{m}}$ (x-axis). Start the y-axis at 0.7 and the x-axis at 1.0. [2]



(ii) Draw the line of best fit on your graph. [2]

Question 5 continues on the next page.

(iii) Determine the gradient G of the line.

G = ... [3]

(d) Calculate the weight of the metre rule using the equation

$$W = \frac{G}{k}$$

where $k = 0.490$ m.

W = ... [2]

(a)		description / diagram showing 2 equal heights from bench	**[1]**
(b)		1.11(1); 1.18(1.176); 1.25(0); 1.33(3); 1.43(1.428)	**[1]**
(c)	**(i)**	Axes suitable and labelled, false origin as instructed	**[1]**
		Plots correct to ½ small sq	**[1]**
	(ii)	Well judged best fit line	**[1]**
		line suitably thin	**[1]**
	(iii)	triangle method seen	**[1]**
		More than ½ line used	**[1]**
		Gradient value correct	**[1]**
(d)		Correct W value using cand's G	**[1]**
		2/3 sf and in N	**[1]**

TOTAL 11

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

Fig. 1.1 shows the apparatus.

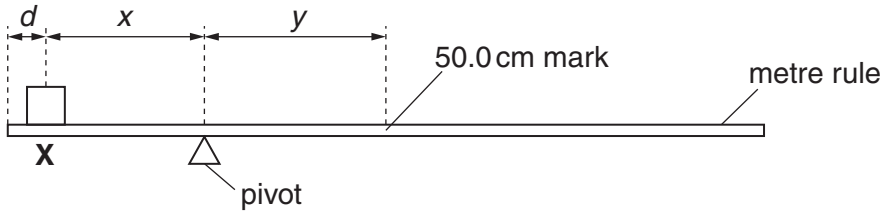


Fig. 1.1

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.

.....

.....

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

.....

.....[2]

[Total: 9]

(a) graph:

axes:	the right way round, labelled *x* and *y* with unit cm	[1]
scale:	both 10 small squares = 2 cm	
	(either or both 20 small squares = 5 cm also acceptable)	[1]
plots:	all correct to ½ small square	[1]
line:	well-judged, best-fit, straight, thin, continuous line	[1]

(b) correct triangle method using at least ½ candidate's line, with method clearly indicated on graph [1]
G = 0.94 – 1.00, no ecf [1]

(c) 1.0/(candidate's *G*) calculation correct, 2 or 3 significant figures and unit N [1]

(d) **(i)** (where rule) balances on pivot o.w.t.t.e. [1]

(ii) take readings from 49.7 OR
adjust rule by adding weight until it balances at 50.0 cm mark [1]

[Total: 9]

3 Some students are determining the weight of a metre rule.
They use the apparatus shown in Fig. 3.1.

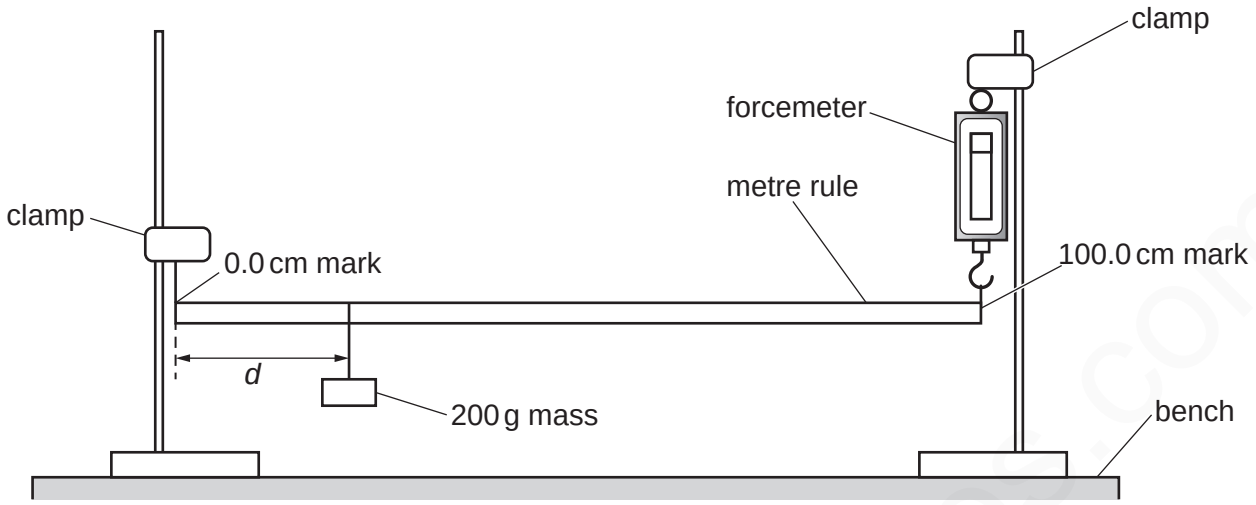


Fig. 3.1

(a) (i) The students suspend a 200 g mass at a distance *d* from the end of the rule.
They then adjust the height of the clamp holding the forcemeter so that the rule is horizontal.

Fig. 3.2 shows the forcemeter when the value of *d* is 10.0 cm.

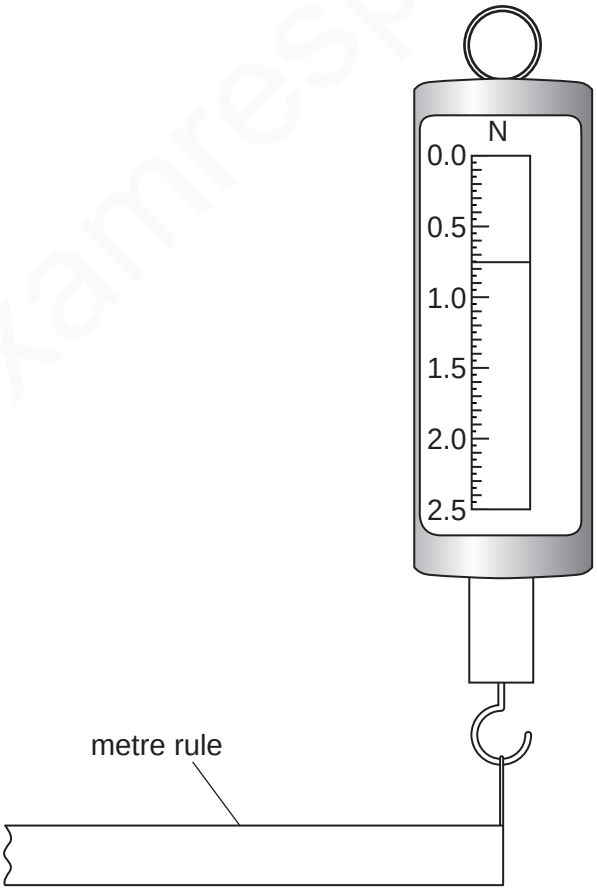


Fig. 3.2

In Table 3.1, record the forcemeter reading F, as shown in Fig. 3.2. [1]

Table 3.1

d / cm	F / N
10.0	
30.0	1.05
50.0	1.65
70.0	1.95
90.0	2.25

(ii) The students repeat the procedure for values of d = 30.0 cm, 50.0 cm, 70.0 cm and 90.0 cm. Their readings are shown in Table 3.1.

Explain how the students could make sure that the rule is horizontal before each reading. You may draw a diagram.

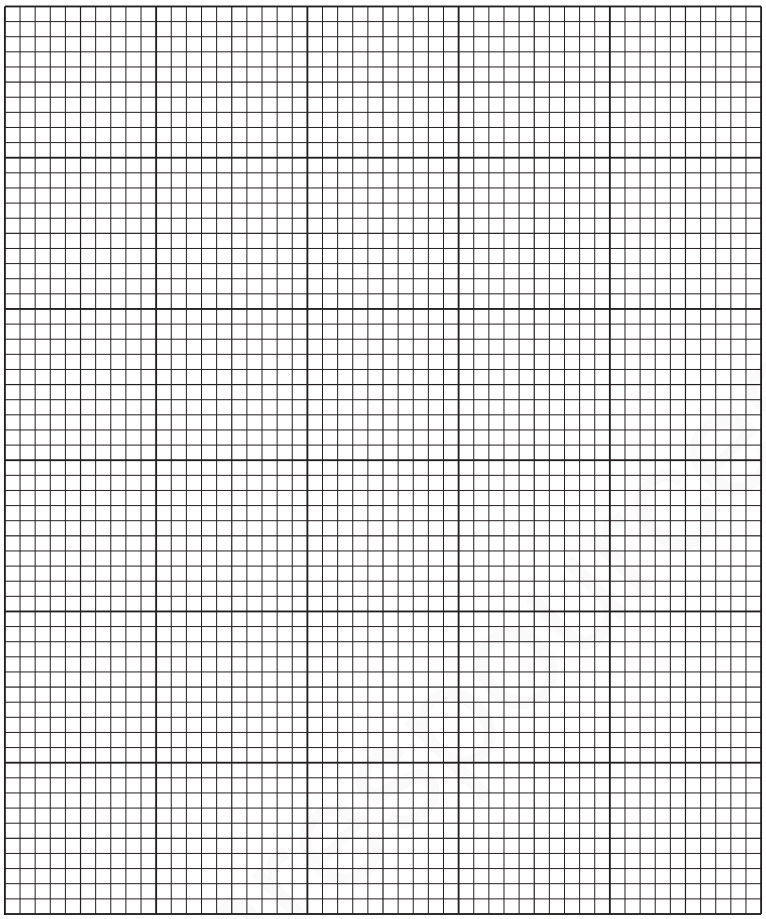
.....

.....

.....[1]

(b) Plot a graph of F/N (y-axis) against d/cm (x-axis).
Start your axes from the origin (0, 0).

Draw a best-fit line.



[4]

(c) **(i)** From your graph, determine F_0, the value of F when d = 0.0 cm.

F_0 = ...[1]

(ii) Calculate the weight W_R of the metre rule, using the equation $W_R = 2 \times F_0$.
Give W_R to a suitable number of significant figures for this experiment.

W_R = ...[2]

(d) A student correctly plots your data points on another sheet of graph paper.

State and explain whether his best-fit line is likely to be the same as yours.
Justify your answer with reference to the plots.

statement .....

explanation .....

.....

.....
[1]

(e) Another student, carrying out the same experiment, is not sure if some of his values of *F* are correct.

Suggest **one** improvement to the procedure which would help him to obtain more reliable *F* values.

.....

.....

.....[1]

[Total: 11]

MARKING SCHEME

3(a)(i)	$F = 0.75$	1
3(a)(ii)	any reliable method e.g. equal distances between rule and bench in at least two places, line up with named horizontal surface, use of set-square between stand and rule	1
3(b)	graph:	
	axes labelled with quantity and unit	1
	appropriate scales (plots occupying at least ½ grid and scales starting at 0,0)	1
	plots all correct to ½ small square AND precise plots	1
	Well-judged line AND thin line	1
3(c)(i)	F_0 correct from graph	1
3(c)(ii)	W_R in range 0.90 to 1.4	1
	2 / 3 sig figs and unit (N)	1
3(d)	statement matching plotted points AND explanation referring to line and scatter of data	1
3(e)	repeat all readings and take average	1

4 A student determines the weight of a metre rule.
She uses the apparatus shown in Fig. 1.1.
The metre rule is supported by a pivot **at the 10.0 cm mark** and is suspended from a forcemeter by a loop of thread at the 90.0 cm mark.

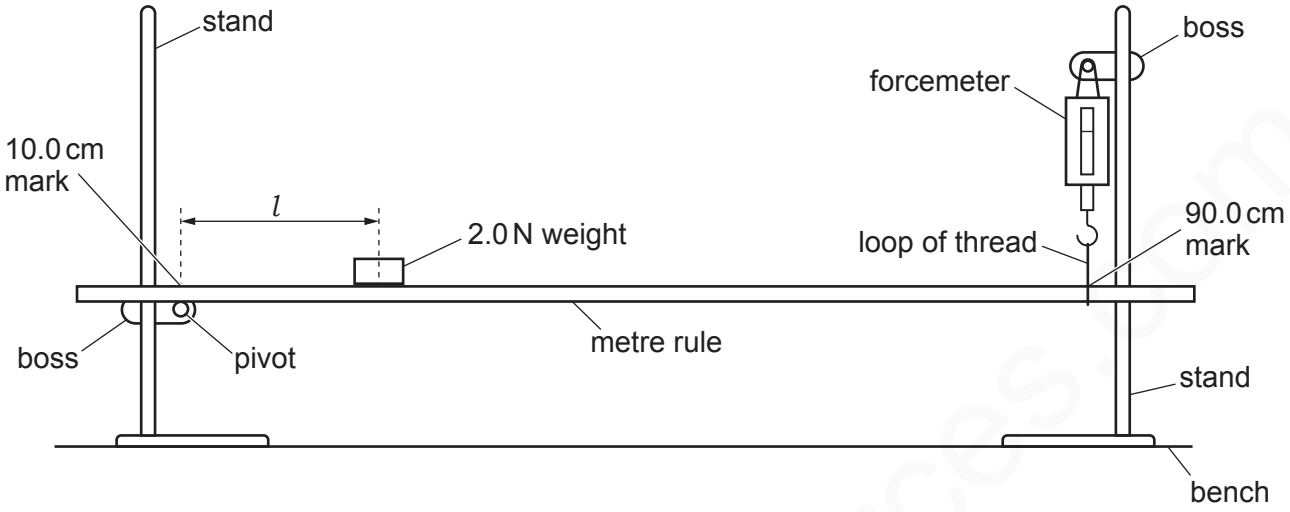


Fig. 1.1

(a) The student places a 2.0 N weight at a distance l from the pivot.
She then adjusts the height of the clamp holding the pivot so that the metre rule is horizontal.
She reads the force F on the forcemeter.
Fig. 1.2 shows the weight and the metre rule from above.
Fig. 1.3 shows the reading on the forcemeter.

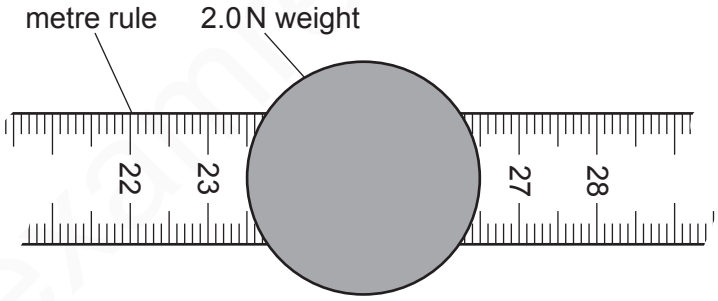


Fig. 1.2 (not to scale)

(i) Calculate the value of l from readings taken from Fig. 1.2.
Show your working clearly.

l = ... cm [2]

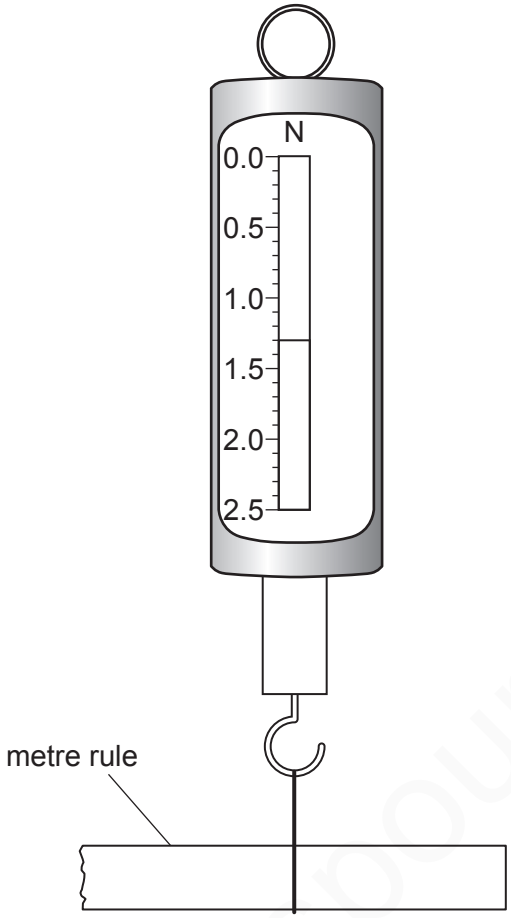


Fig. 1.3

(ii) Read the value *F* shown on the forcemeter in Fig. 1.3.

F = ... N [1]

(iii) Explain how the student makes sure that the rule is horizontal before taking the reading. You may draw a diagram.

.....

.....

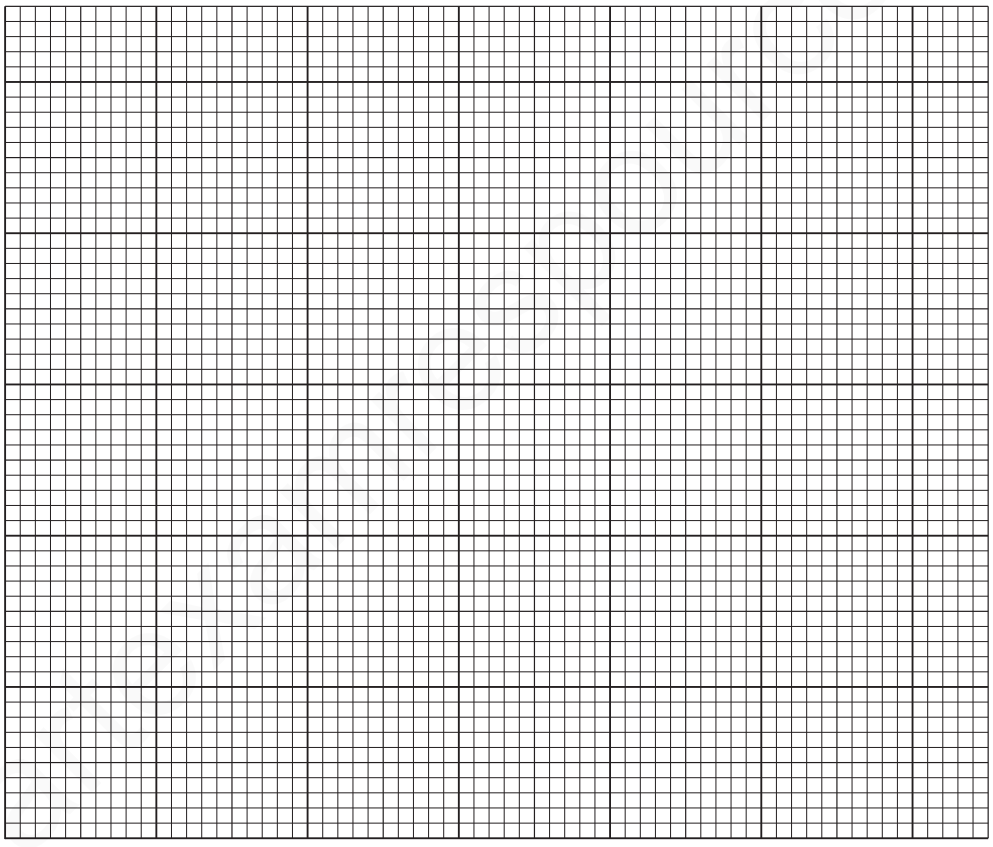
..... [1]

(b) The student carries out the procedure for values of l = 20.0 cm, 30.0 cm, 40.0 cm, 50.0 cm and 60.0 cm. Her readings are shown in Table 1.1.

Table 1.1

l / cm	F / N
20.0	1.35
30.0	1.60
40.0	1.90
50.0	2.15
60.0	2.45

Plot a graph of F / N (y-axis) against l / cm (x-axis).
Start your axes from the origin (0,0).



[4]

(c) **(i)** From your graph determine F_0, the value of F when l = 0.

F_0 = ... N [1]

(ii) Calculate the weight W_R of the metre rule, using the equation $W_R = 2 \times F_0$.

W_R = ... N [1]

(d) Another student carrying out this experiment finds it difficult to be sure that he has placed the centre of the 2.0 N weight on the metre rule at the correct value of l.

Suggest a more precise method of applying a 2.0 N load to the metre rule in this experiment. Explain why this method is an improvement.

.....

.....

..... [1]

[Total: 11]

MARKING SCHEME

1(a)(i)	l = 15.0 (cm)	1
	centre of weight at 25(.0) cm seen or implied / clear subtraction of 10.0 cm from candidate's value	1
1(a)(ii)	1.3 (N)	1
1(a)(iii)	ensure distances from bench at both ends are equal OR use set square between rule and stand OR align with known horizontal line (e.g. window ledge)	1
1(b)	graph: • axes labelled with quantity and unit	1
	• appropriate scales (plots occupying at least $\frac{1}{2}$ grid)	1
	• plots all correct to $\frac{1}{2}$ small square and precise plots	1
	• well judged line and thin line	1
1(c)(i)	F_0 correct from graph	1
1(c)(ii)	W_R in range 1.2 to 2.0	1
1(d)	hang load from cotton loop on metre rule and cotton can be placed on precise mark on metre rule	1