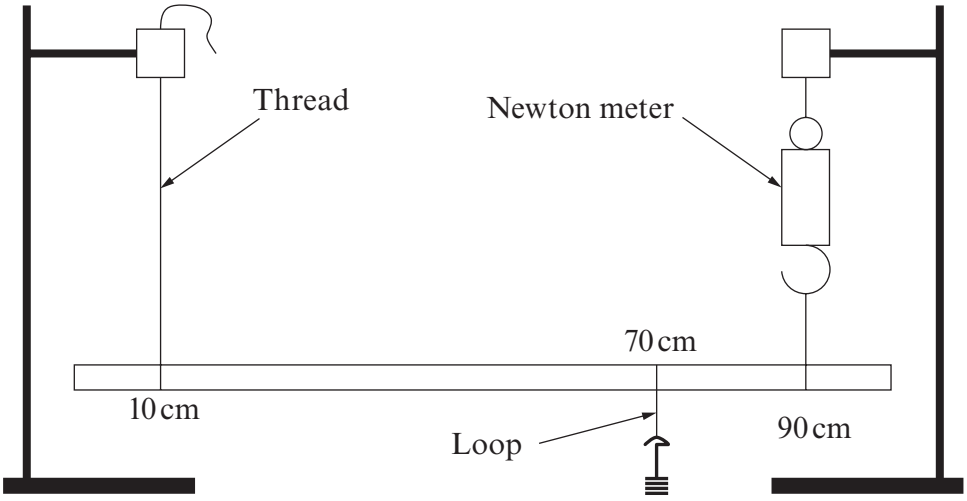
Examiner only

Task A2 (15 minutes)

You are going to use the apparatus set-up as shown below, and the principle of moments to determine the weight of the metre ruler.



(a) **Draw** an arrow, labelled **W**, on the diagram to represent the weight of the ruler acting through the centre of gravity. [1]

(b) Attach the 4.0 N weight to the loop and move it to the 70 cm mark on the ruler. Adjust the length of the thread until the ruler is horizontal. Write down the reading of the Newton meter. **Repeat readings are not needed**. [1]

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(c) By taking moments about the 10 cm point, determine a value for the weight of the ruler. [3]

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Examiner only

(d) Move the 4.0 N weight to the 30 cm mark on the ruler and again adjust the length of the thread until the ruler is horizontal. Use the new reading on the Newton meter to calculate a second value for the weight of the ruler. [2]

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(e) Which of your two Newton meter readings has the smallest **percentage** uncertainty? Give a reason for your answer. [1]

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8

1323 01A007

Turn over.

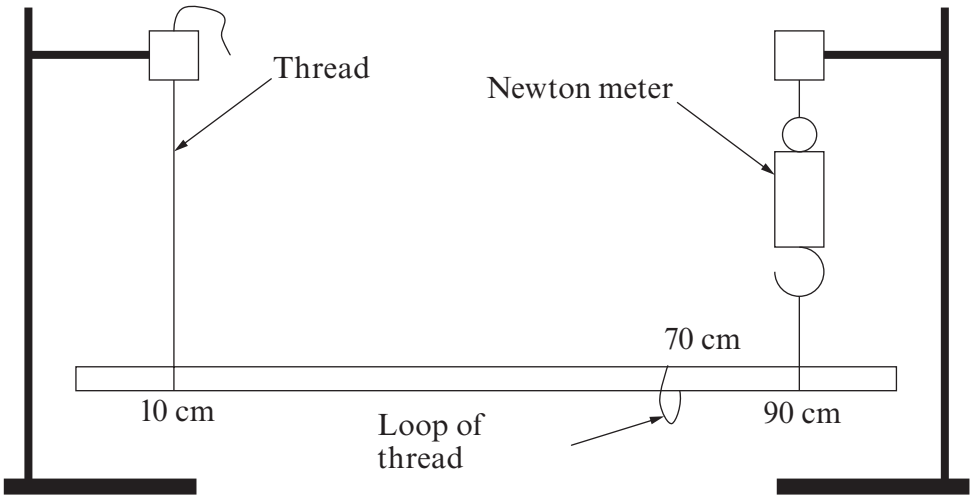
TASK A2

Candidates will be expected to investigate the apparatus set-up shown below:

Test 1:

2 × Clamps and stands
2 × 'G' clamps to stabilise stands
2 × metre rulers
Newton meter 0 – 10 N (± 0.1 N or 0.2 N)
Split cork
400 g mass (including holder) – the masses to be taped together
Thread

The apparatus should be set up as shown below. The loop should be put on the ruler close to the 70 cm mark but with no 4.0 N weight attached.



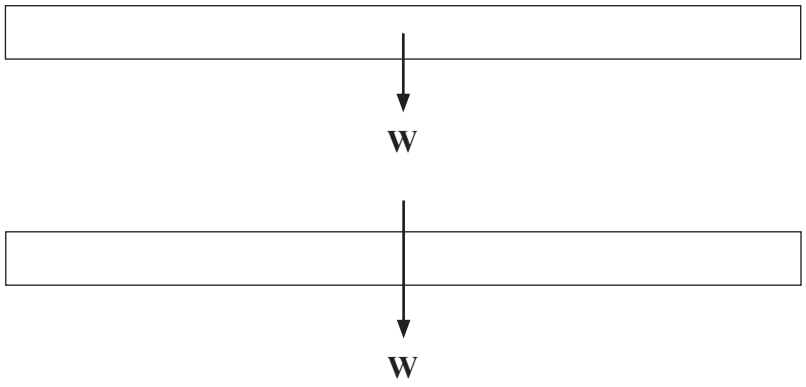
Test 2:

The apparatus is as for Test 1 except a 300 g mass (including holder) should be used and the loop should be put on the ruler close to the 80 cm mark.

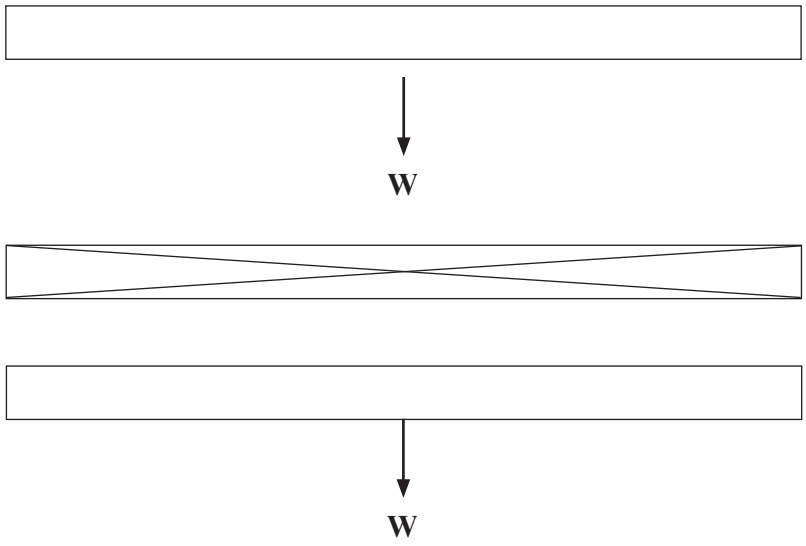
A2 *(a)* Position marked in middle of ruler (by eye) with arrow vertically downwards
N.B. arrow must touch ruler – may be above or below [1]

Examples:

Acceptable answers:



Not acceptable answers:



(b) Reading to 2 sig. figs. i.e. to resolution of Newton meter (allow to ½ scale division) with unit (N) [1]

(c) Attempt to equate moments even if incorrect [e.g. Newton meter × 90 = weight × 50] *(1)*
Correct equation and rearrangement *(1)*
Weight ± 10% of centre value *(1)*
(no e.c.f. allowed within the question) [3]

(d) Weight calculated correctly *(1)*
Unit (N) in **both** *(c)* and *(d)* (stand alone mark i.e. can be awarded even if weight values are incorrect) *(1)* [2]

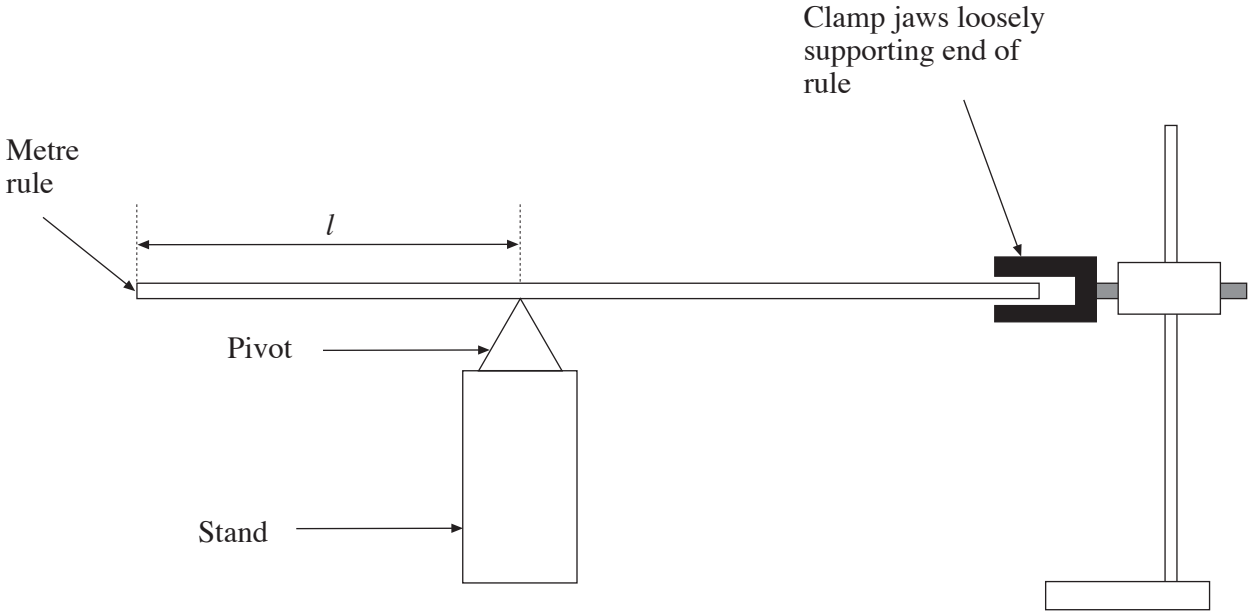
(e) *(c)* lower [%], larger value on Newton meter
N.B. no e.c.f. allowed [1]

Total [8]

TASK A2 (15 minutes)

Repeat readings are not required for this task.

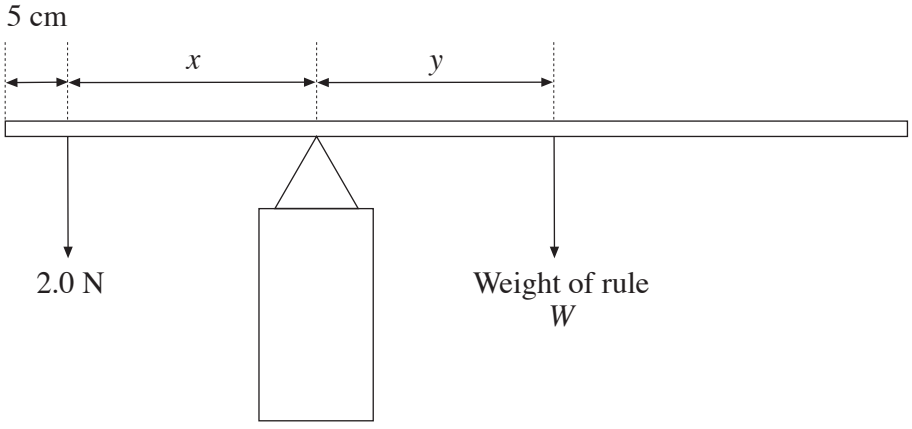
(a) You are provided with the following apparatus.



Adjust the rule until it is just, **or very nearly**, balanced. The balance point is known as the centre of gravity of the rule. This is the point through which the whole of the weight of the rule, W, can be thought to act. Make a note of the length, *l*. [1]

l = ... cm

(b) Hang a weight of 2.0 N a distance of 5.0 cm from the left hand end of the rule, as shown, and once again adjust the rule so that it balances.



(i) Measure the distances *x* and *y*. [1]

x = ... cm *y* = ... cm

(ii) The Principle of Moments applied to this situation leads to the following equation:

$$2.0x = Wy$$

Use your results in *(b)*(i) to determine a value for *W*. [2]

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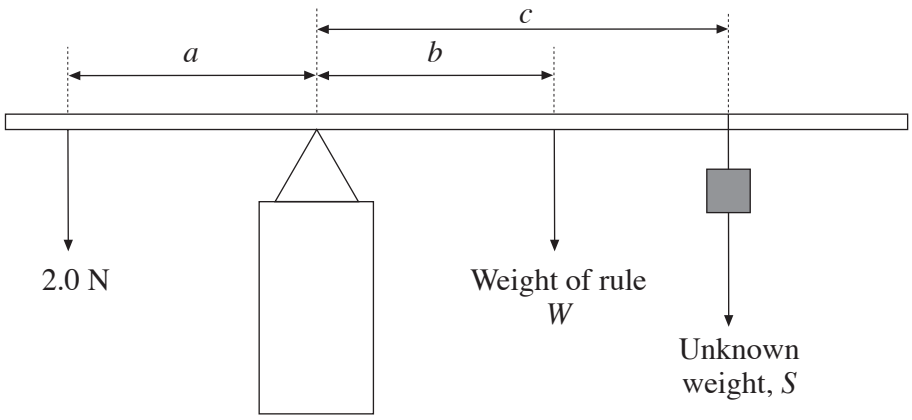
(c) Hang the unknown weight, *S*, on the opposite side to the 2.0 N weight and once again balance the rule.



Record the values of *a*, *b* and *c*. [1]

a = ... cm *b* = ... cm *c* = ... cm

Use the above information, and your value for the weight of the rule in *(b)* to calculate the unknown weight. [3]

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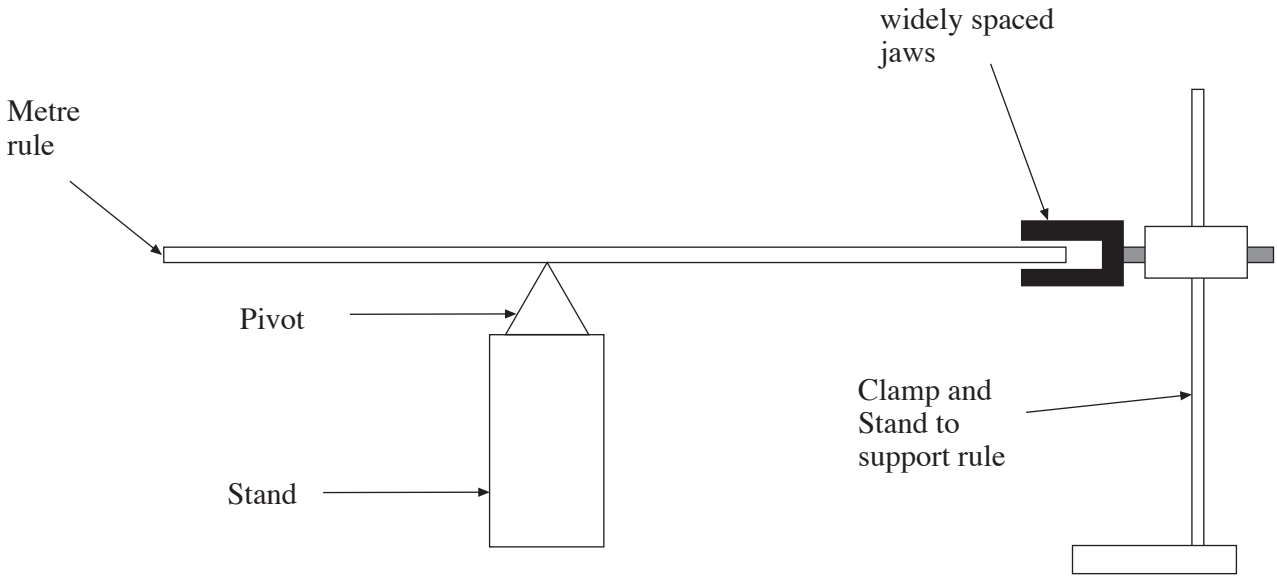
TASK A2

The candidates will be expected to investigate the balance of a metre rule, both loaded and unloaded.

Test 1



The above apparatus should be set up for the candidates at the start of the task. The clamp should support the metre rule only loosely.

Apparatus required:

1 × metre rule with a resolution of 1mm
1 × 2.0 N weight (200g including hanger) - the candidates should easily be able to hang it from the rule at any position
1 × clamp and stand
1 × stand and pivot, e.g. wooden block and prism (which need not have a sharp edge)
1 × unknown weight, labelled **S**. This should have a mass of approximately 60 grams, and could consist of a glass stopper or a small coil of wire. Other objects of approx. this mass could also be used. Please check before the experiment that the unknown mass is suitable to balance the 2.0 N weight. This object should be attached to a thread loop to allow it to be hung from the ruler without the candidates' having to tie any knots.

N.B. For ease of marking, centres should, where possible, select ruler with similar mass and which balance near the 50cm mark.

ADDITIONAL INFORMATION FOR SUPERVISORS

It is not anticipated that candidates should spend a long time to balance the rule exactly; answers within a couple of mm will be good enough. If you feel a candidate is taking too long then please encourage them to move on to complete the rest of the question.

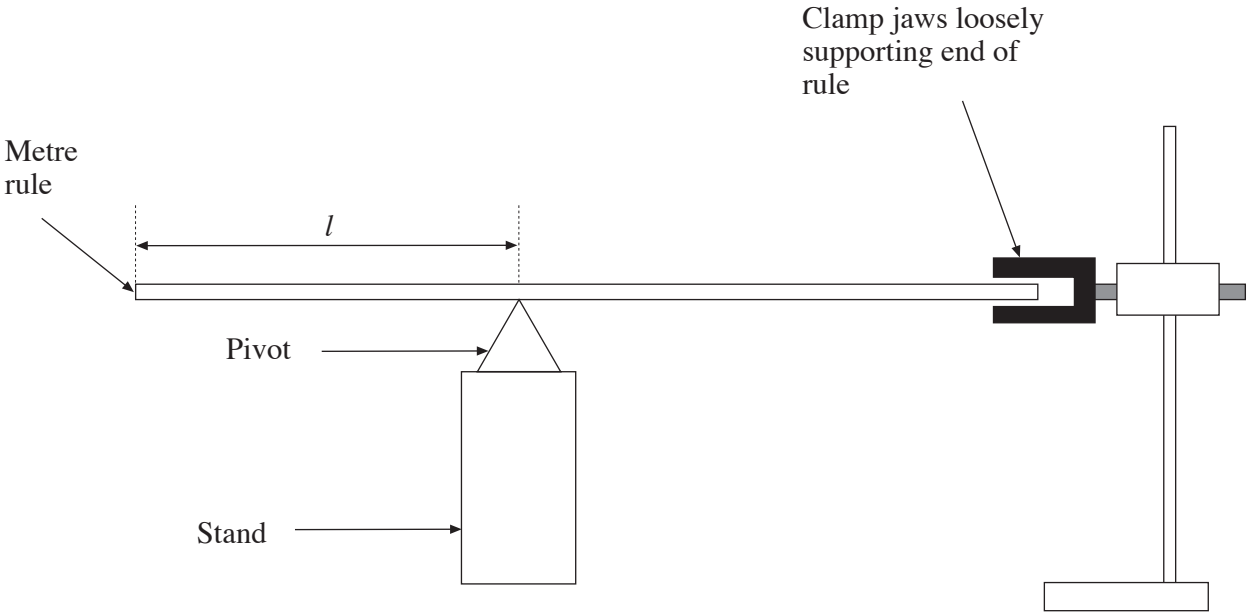
Test 2:

The apparatus is as for **Test 1** except that a different unknown mass (e.g. 70-80 g) should be used.

TASK A2 (15 minutes)

Repeat readings are not required for this task.

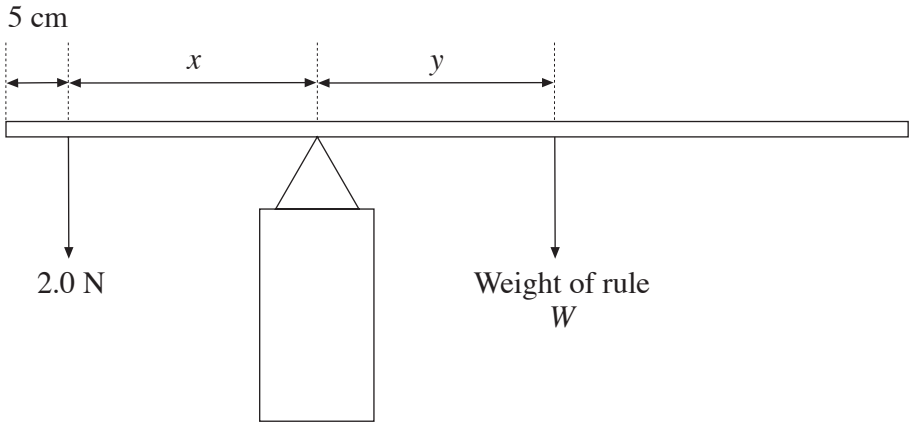
(a) You are provided with the following apparatus.



Adjust the rule until it is just, **or very nearly**, balanced. The balance point is known as the centre of gravity of the rule. This is the point through which the whole of the weight of the rule, W, can be thought to act. Make a note of this length, *l*.

Answer given to 1 d.p. within 0·5cm of the centre value (1)

(b) Hang a weight of 2.0N a distance of 5.0 cm from the left hand end of the rule, as shown, and once again adjust the ruler so that it balances.



(i) Measure the distances *x* and *y*. [1]

x = ... cm *y* = ... cm

Both values to 1 d.p. and ***within 0.5cm of centre value*** *(1)*

(ii) The Principle of Moments applied to this situation leads to the following equation:

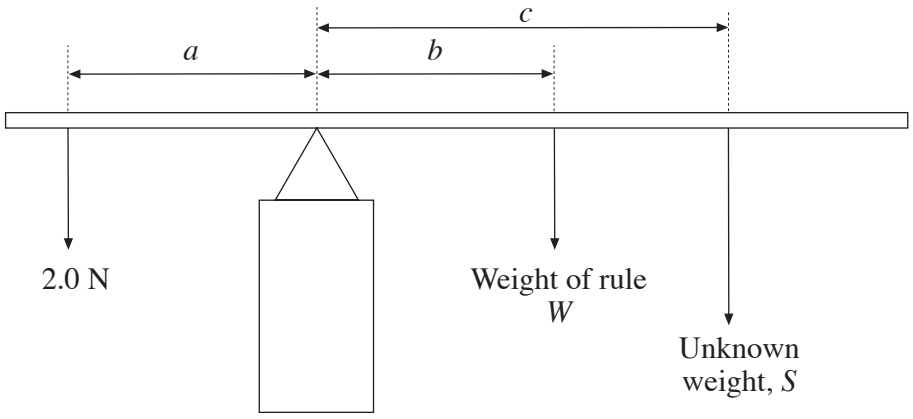
$$2.0x = Wy$$

Use your results in *(b)*(i) to determine a value for W (in newtons). [2]

Weight correct to 5% of true value (1)

Units newton / N (1) [Accept: Newton(s)]

(c) Hang the unknown weight, S, on the opposite side to the 2.0N weight and once again balance the rule.



Record the values of a, b and c. [1]

All values recorded to 1 d.p. (1)

Use the above information, and your value for the weight of the rule in *(b)* to calculate the unknown weight. [3]

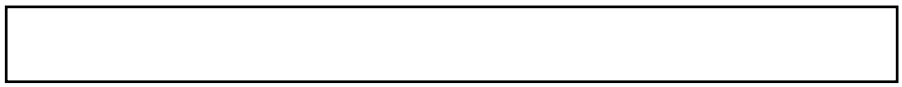
$2a = Wb + Sc$ (1) [or by impl.]

S calculated correctly (1)

*S correct to ± **0.2N of centre value** (1)*

Experiment 1

You are going to determine the weight of a uniform metre ruler, and then use this result to find the weight of a reel of wire.

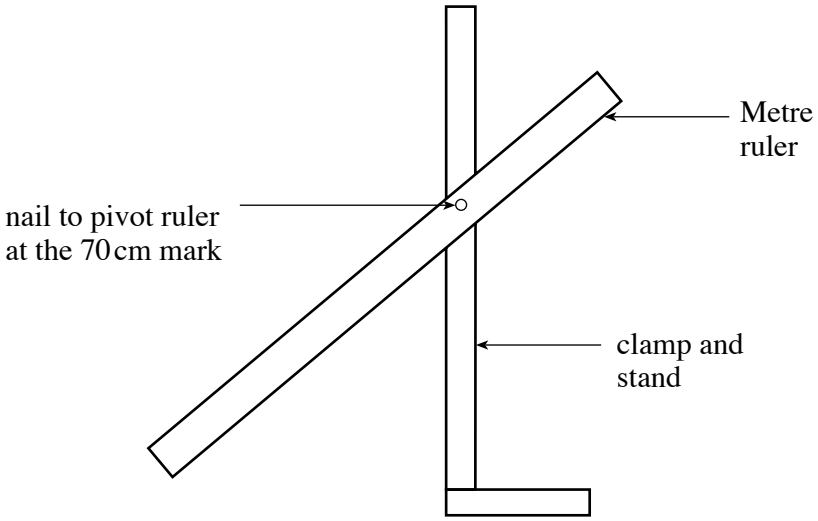


(a) (i) Carefully, draw on the diagram the point through which all of the weight of the ruler can be considered to act. [2]

(ii) What is the name given to this point? [1]

.....

(b) Set up the apparatus as shown, with the ruler pivoted at the 70 cm mark.



(i) Loop the 200 g mass over the metre ruler and adjust it until the ruler is horizontal. Note down the distance of the mass from the pivot. [1]

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(ii) Calculate the weight (in newtons) of 200 g.
(for the purpose of this question take the acceleration due to gravity as 10 ms^{-2}) [1]

.....

(iii) A moment about a pivot is defined as force × perpendicular distance from pivot. Calculate the moment about the pivot due to the weight of the 200 g mass. [1]

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(iv) State the Principle of Moments, and then calculate the weight of the ruler. [2]

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(c) You are now going to use the weight of the ruler to find the weight of a reel of wire. Remove the 200g mass and replace it with the reel of wire. Pivot the ruler at the 55 cm hole and move the reel of wire until it balances.
By calling the weight of the reel of wire *W*, the moment of the weight of the wire will become *W* × perpendicular distance to pivot.

(i) Complete the table with the ruler pivoted at each of the drilled holes. [4]

Distance from centre of ruler to pivot (cm)	Distance from pivot to wire reel (cm)			Moment due to the weight of the ruler (Ncm)	Moment due to the wire reel (Ncm)	Weight of the wire reel (N)
	1	2	Ave			
5·0					× *W*	
10·0					× *W*	
15·0					× *W*	
20·0					× *W*	
25·0					× *W*	

(ii) Which of your results for the weight of the wire reel would you expect to give the greatest error? Explain your reasoning. [2]

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(iii) Use your results to calculate an average value for the weight of the reel of wire. [2]

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(d) The uncertainty, Unc(W) in the value for the wire reel's weight can be calculated using the expression

$$\text{Unc}(W) = \frac{W_{\text{max}} - W_{\text{min}}}{2}$$

where W_{max} and W_{min} are the maximum and minimum values of the wire's weight W.

(i) Calculate the uncertainty in your result. [1]

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(ii) Your results for this experiment can be said to be reliable if they are all within 5% of the average value. Comment on the reliability of your results. [2]

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(iii) How could you adapt this experiment to further improve its reliability? [1]

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Experiment 1

Test 1

Candidates will be expected to investigate the weight of a metre ruler, and find the weight of a reel of wire.

Apparatus required:

1. 1 retort stand boss and clamp.
2. 1 metre wooden ruler with holes drilled near the top edge at 55cm, 60cm, 65cm, 70cm and 75cm.
3. 1 flat headed nail to act as a pivot – must be free to move when placed through the holes drilled in the ruler.
4. 200g mass.
5. Pre-tied loop to allow suspension of 200g mass.
6. Reel of wire of mass 110g to 130g with a pre-tied loop of thin string to allow it to be suspended over the ruler.

The nail pivot should be set up in the clamp stand at a suitable height.

Test 2

The apparatus is as for Test 1, except that the mass of the reel of wire should be in the range 140-160g.

Experiment			Marks Available
1. *(a)*	(i)	Point in middle of ruler (1) Diagonals /axes of symmetry drawn to show exact centre	2
	(ii)	Centre of gravity [accept centre of mass]	1
(b)	(i)	Correct distance (to nearest mm) with unit	1
	(ii)	$0{\cdot}2 \times 10 = 2$ N [accept $1{\cdot}96$ N]	1
	(iii)	Correct calculation [(i) × (ii)] - no unit penalty	1
	(iv)	Principle of Moments stated [allow lack of reference to a particular point] (1) Weight correctly calculated(1)	2
(c)	(i)	All readings taken [table complete] (1) [Allow 4 sets of readings, if the ruler is too heavy] All readings to 1 d.p. [rule resolution] (1) Moment and weight calculated correctly (1) Moment and weight quoted to 2 or 3 s.f. (1)	4
	(ii)	Smallest distance from pivot/ 55 cm pivot (1) 1 mm error gives largest % error [or equiv.] (1)	2
	(iii)	Correct calculation (1) Accurate vlaue to 2 or 3 s.f. (1) [no unit penalty]	2
(d)	(i)	Correct calculation [no unit penalty] (1)	2

(ii)	5% of average calculated (1) Compared with *(d)*(i) and reliability correctly reported (1) [or equivalent method using the uncertainty formula]	2
(iii)	Take more repeat readings or use a larger range.	1
	Total mark	**[20]**