

Investigation of the Principle of Moments

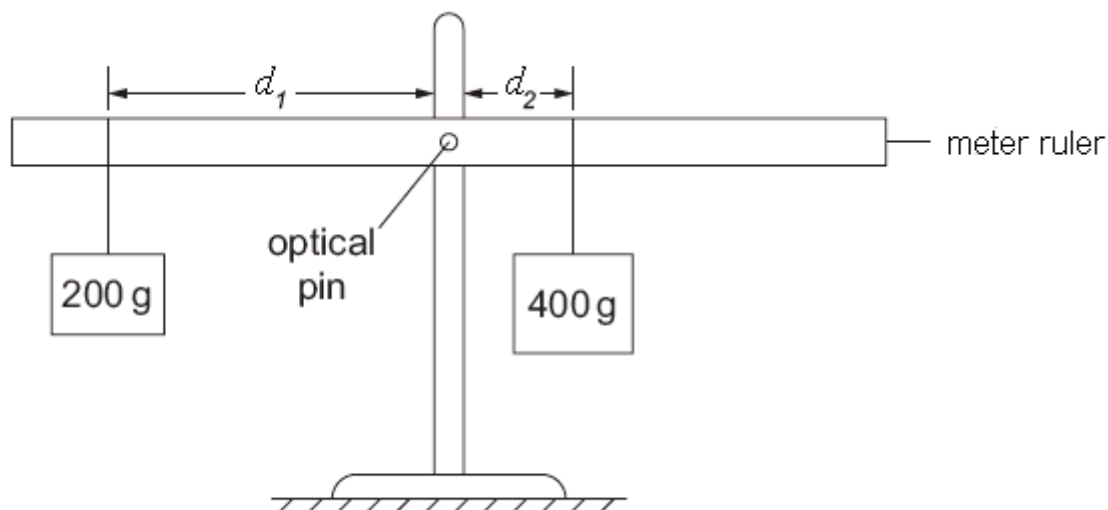
Introduction

A force can have a moment (turning effect) about a hinge or a pivot which may be clockwise or anticlockwise. For any object in equilibrium the total clockwise moment must be equal to the total anticlockwise moment. In this investigation a metre ruler and 100 g masses are used to verify the Principle of Moments.

Apparatus

metre ruler with small hole at centre
 $2 \times 100\text{g}$ mass hangers
 $8 \times 100\text{g}$ masses
 $2 \times$ loops of cotton
 clamp stand, boss and clamp
 optical pin and cork
 small piece of plasticine

Diagram of Apparatus



Method

1. Add plasticine to one end of the metre ruler so that it is balanced.
2. Use a cotton loop to hang a mass of 200g at the 10cm mark on the metre rule ($d_1 = 40$ cm).
3. Use a cotton loop to hang a mass of 400g on the other side of the pivot so that the metre rule is balanced once again. Record the distance d_2 .
4. Repeat steps 2 and 3 for $d_1 = 30$ cm and then $d_1 = 20$ cm.
5. Use a cotton loop to hang a mass of 200g at the 5cm mark on the metre rule ($d_1 = 45$ cm).
6. Use a cotton loop to hang a mass of 600g on the other side of the pivot so that the metre rule is balanced once again. Record the distance d_2 .
7. Repeat steps 5 and 6 for $d_1 = 30$ cm and then $d_1 = 15$ cm.
8. Use a cotton loop to hang a mass of 200g at the 10cm mark on the metre rule ($d_1 = 40$ cm).
9. Use a cotton loop to hang a mass of 800g on the other side of the pivot so that the metre rule is balanced once again. Record the distance d_2 .
10. Repeat steps 8 and 9 for $d_1 = 20$ cm.

Analysis

1. Calculate the clockwise and anticlockwise moment for each mass using the following formula ($100\text{g} = 1\text{ N}$):

$$\text{Moment} = F d$$
2. Determine if the Principle of Moments is satisfied for each pair of values.

Risk Assessment

Hazard	Risk	Control measure
There are no significant risks associated with this procedure.		

Teacher / Technician Notes

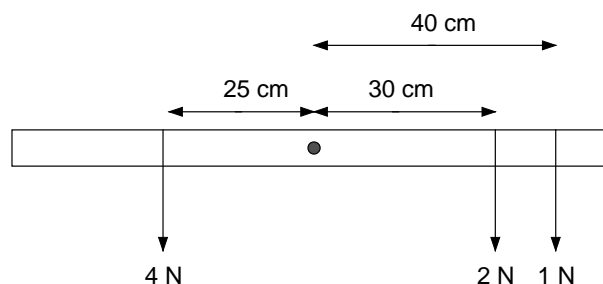
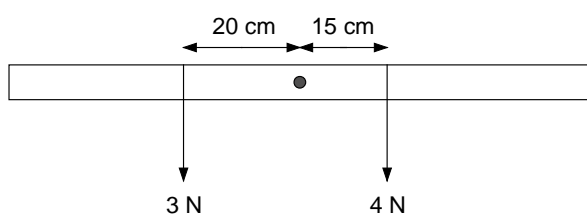
The apparatus should be set up for the students. The use of a little plasticine and the meaning of a “balanced” metre ruler should be demonstrated. Students should understand the terms clockwise and anticlockwise moment

Students should design their own table, but a suggested table format is shown below.

Mass (g)	Weight, W_1 (N)	Distance, d_1 (cm)	Mass (g)	Weight, W_2 (N)	Distance, d_2 (cm)	Anticlockwise moment $W_1 \times d_1$ (N cm)	Clockwise moment $W_2 \times d_2$ (N cm)
200	2	40	400	4			
200	2	30	400	4			
200	2	20	400	4			
200	2	45	600	6			
200	2	30	600	6			
200	2	15	600	6			
200	2	40	800	8			
200	2	20	800	8			

Alternative apparatus that could be used to verify the principle of moments: flat wooden rods, square brass masses, pivots and pins.

Students could be challenged to test their understanding by predicting and testing other combinations of masses that would produce a balanced metre ruler. This could be extended from 2 to 3 sets of masses. They could be asked to produce simple diagrams of their successful experiments, e.g.



Working scientifically skills covered

2. Experimental skills and strategies

Plan experiments or devise procedures to make observations, produce or characterise a substance, test hypotheses, check data or explore phenomena.

3. Analysis and Evaluation

Carry out and representing mathematical analysis.

Evaluate data in terms of accuracy, precision, repeatability and reproducibility and identifying potential sources of random and systematic error.

4. Scientific vocabulary, quantities, units, symbols and nomenclature

Use SI units and IUPAC chemical nomenclature unless inappropriate.

Interconvert units