PRACTICAL Name:

3.1 The principle of moments

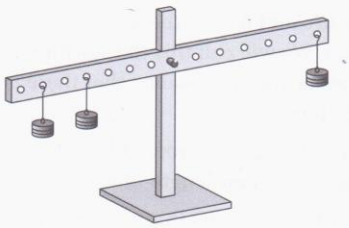
Aim: To understand and apply the principle of moments using a lever.

Equipment:

- Stand, boss, and short metal rod to act as the fulcrum
- 50 cm rigid metal strip with holes drilled and labelled every centimetre along its length to act as a balance bar
- 6 × 20 g slotted or hanging masses

Introduction

The turning effect of a lever not only depends on the magnitude of the force, but also the length of the lever arm. The length of the lever arm is the perpendicular distance between the pivot point (fulcrum) and the line of application of the force.



Theory

The turning effect of a force is called its moment. When an object is in equilibrium, the sum of the clockwise moments is equal to the sum of the anticlockwise moments at that point.

The moment of a force about a pivot point is the force multiplied by the perpendicular distance from the pivot point. For two forces, F_1 and F_2, both acting downwards at perpendicular distances, d_1 and d_2, either side of the fulcrum:

$$F_1 \times d_1 = F_2 \times d_2$$

A lever is a simple machine that requires a rigid beam and a pivot point. It is usually used to amplify a force to lift a load. The mechanical advantage, or amplification factor, is defined as the ratio between the load and the effort.

$$\text{mechanical advantage} = \frac{\text{load}}{\text{effort}}$$

Method

Set up the balance bar with the fulcrum at its centre. The balance bar should be free to rotate about the pivot point.

Experiment number	Load (masses to the left of fulcrum)	Effort (masses to the right of fulcrum)	Is the lever in equilibrium?	Mechanical advantage of the lever
1	20 g at 10 cm	20 g at 10 cm		
2	2 × 20 g at 5 cm	1 × 20 g at 10 cm		
3	3 × 20 g at 4 cm and 1 × 20 g at 12 cm	2 × 20 g at 12 cm		
4	3 × 20 g at 6 cm and 1 × 20 g at 12 cm		yes	

If the balance bar is not horizontal (balanced) a small mass may need to be attached to the back of the rule with adhesive tape to balance it.

Add masses to the balance bar according to the following table and complete the empty boxes.

Question

Using the principle of moments, calculate the position of a 20g mass to counter-balance four masses: 1 × 50 g at 6 cm, 1 × 20 g at 8 cm, 1 × 10 g at 10 cm, and 1 × 5 g at 12 cm. Show your working.