

Chapter 7 Building it up

Short investigation 7.1: Rotational equilibrium

Name:

Aim

To study the effects of torque and to understand the concept of rotational equilibrium

Materials

Metre ruler with a hole drilled through at its centre point, small spirit level, masking tape, two sets of slotted brass weights (50 g increments) and hangers, string, plasticine, retort stand and clamp

Method

1. Place the metre ruler on its edge on the benchtop. Use masking tape to attach the spirit level to the top edge of the metre ruler so that the bubble lies directly above the hole in the ruler.
2. Set up the retort stand and attach the clamp in such a way that the long clamp arm is facing outwards.
3. Attach the ruler to the stand by passing the clamp arm through the hole in the ruler. Check that the ruler is level by referring to the spirit level. If it is not, add plasticine to the higher end of the ruler until the ruler is level.
4. Cut two pieces of string and form them into loops of approximately the same size and hang them from the opposite ends of the ruler.
5. Load one of the weight sets to 400 g and hang it from one of the loops; load the other set to 100 g and hang it from the opposite loop.
6. Slide the 400 g weight loop along the ruler until it is 10 cm from the centre of the ruler.
7. Slide the 100 g weight loop along the ruler until the ruler is level again. Note the distance d (in cm) of the loop from the centre of the ruler and enter this value in table 7.1A.
8. Leaving the 400 g weight in the 10 cm position, add 50 g to the other weight set and repeat step 7. Continue to add 50 g weights until 400 g is reached.

Results

Table 7.1A

Mass (g)	d (cm)
100	

150	
200	
250	
300	
350	
400	

Analysing the results

1. During each trial, when could the ruler be said to have reached rotational equilibrium?
2. In what direction (clockwise or anticlockwise) was the rotation of the ruler due to the:
 - (a) 400 g load?
 - (b) varying load?
3. Calculate the torque that is exerted on the ruler by the 400 g weight set, given that the torque $\tau = F \times d$, where F is equal to the weight of the 400 g load (in N) and d is the distance of the load from the pivot point (in m).
4. Calculate the torque resulting from the placement of the variable weight set for each of the values given in table 7.1A:
 - (a) 100 g:
 - (b) 150 g:
 - (c) 200 g:
 - (d) 250 g:
 - (e) 300 g:
 - (f) 350 g:
 - (g) 400 g:
5. In theory, the torque calculated for each load in question 2 should be equal to the torque of the 400 g load calculated in question 1. Determine the average investigational error (as a %) in your results.
6. What were the main sources of error in this investigation?

7. Give 2 examples of the every day use of rotational equilibrium and torque.

Conclusion

State the relationship between the torques acting on the ruler if it is to be in rotational equilibrium.

Notes: