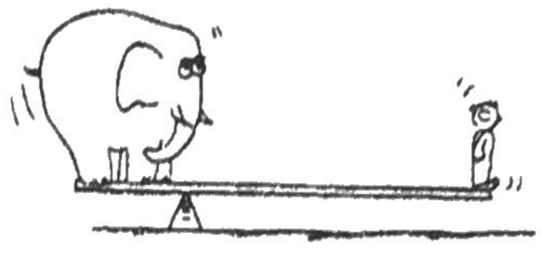
LAB: WEIGHING AN ELEPHANT

PURPOSE: To use the principle of balanced torques to find the value of an unknown mass.

MATERIALS: half meter stick, support stand, set of known masses, unknown mass



PART I

A. Carefully balance a meter stick horizontally on the support stand.

B. Suspend a 200-g mass 10-cm from the fulcrum. Suspend a 100-g mass on the opposite side.
NOTE – Each mass hanger is 22 grams.

1. Can you make a 100 g mass support a 200 g mass?

2. Use the table below. Complete 4 trials where you place 1 mass on one side and a different mass on the other side and the meter stick is balanced.

TRIAL #	Small Mass (g)	Distance from Fulcrum (cm)	Large Mass (g)	Distance from Fulcrum (cm)
1				
2				
3				
4				

3. Discover a pattern in the data from above. State this pattern in words.

4. Use a formula to state this pattern.

5. If an elephant has a mass of 2450 kg and stands 2 m from the fulcrum. How far from the fulcrum would a 140-lb person have to be to balance the elephant? (1 lb = 4.4 N)

6. If you are on a seesaw with your younger sister (who weighs much less than you), what can you do to balance the seesaw?

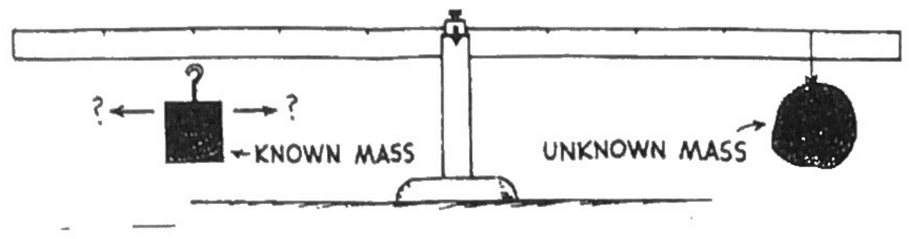
7. Greg (90 kg), Peter (70 kg), and Bobby (40 kg) all want to balance on a seesaw. If Peter sits on the left end, where can Greg and Bobby position themselves so that equilibrium is achieved? The length of the seesaw is 6.0 m and its fulcrum is located at the center. (No laps, find an answer using only integers.)

8. Can you come up with a second solution to the previous problem if acceptable distances from the fulcrum are multiples of 0.5?

PART II - DETERMINING AN UNKNOWN MASS

C. Obtain an unknown mass and position it somewhere on the meter stick. The fulcrum should still be at the middle of the meter stick.

9. Using one of your known masses, determine what the value of the unknown mass. Show your work below.



Take the unknown mass to the balance and determine its mass. Record this below. Determine the percent error between your computed result and the actual result.

10. Mass from balance = _____ 11. Percent Error:

PART III - DETERMINING THE MASS OF THE METER STICK

D. Lift the half meter stick apparatus out of the stand. Place a pencil in the groove and balance a regular length meter stick on top of that. (Note – it's difficult to achieve balance on top of a pencil and the meter stick might not balance exactly at the 50 cm mark. Call me over if you can't get it to balance between 49 and 51 cm.) Once you have confirmed that the COM for the meter stick is approximately at the 50 cm mark, slide the meter stick down so that the fulcrum is on the 80-cm mark. Balance the meter stick using a single mass hung between the 80 cm and 100 cm mark.

12. How far is the mass of the meter stick from the fulcrum?

13. Compute the mass of the meter stick. Show your work below.

Determine the actual mass of the meter stick by using the balance.

14. Actual mass = _____ 15. Percent Error:

PART IV - CENTER OF MASS OF A 1-D SURFACE

E. The purpose of this part of the activity is to calculate the center of mass of a non-uniform body.

16. Take the meter stick off the support stand. Add different masses to both ends of the meter stick. Determine the center of mass of the meter stick mathematically by using the formula below:

$$\frac{m_1x_1 + m_2x_2 + m_3x_3}{m_1 + m_2 + m_3} = x_{com}$$

Call one end of the meter stick the zero position and measure your distance from there. Remember to include the meter stick itself as one of the objects.

17. To see if you are right, place one finger under your predicted center of mass. Does the meter stick balance?

Additional Questions

18. A 200 gram mass is positioned 35 cm away from the fulcrum of a seesaw. Where could a 300 gram mass be placed on the other side for the system to be balanced?

19. An unknown mass is placed 11 cm away from the fulcrum of a seesaw. Balance is achieved when a 50 gram mass is placed 28 cm away from the fulcrum. What is the unknown mass?

20. A fulcrum is placed below a meter stick at the 30 cm mark. A 100 gram mass is positioned at the 15 cm mark to balance the meter stick. What is the mass of the meter stick?

21. The same meter stick from the previous problem has a 200 gram mass placed at the 80 cm mark (in addition to the 100 gram mass that is still at the 15 cm mark). In order to balance this meter stick on one finger, where should you position it?