Name ______________________ Period ________ Date ________

Keeping in Balanace — Lab 10.1

Purpose

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

Required Equipment

meterstick standard
mass with hook
rock
triple beam balance
string
masking tape

Discussion

Gravity pulls on every part of an object. It pulls more strongly on the more massive parts of objects and more weakly on the less massive parts. The sum of all these pulls is the weight of the object. The average position of the weight of an object is its center of gravity, or CG. The whole weight of the object is effectively concentrated at its center of gravity. The CG of a uniform meterstick is at the 50 cm mark. In this experiment you will balance a meterstick with a known and an unknown mass, and compute the mass of the unknown. Then you will simulate a "solitary see saw".

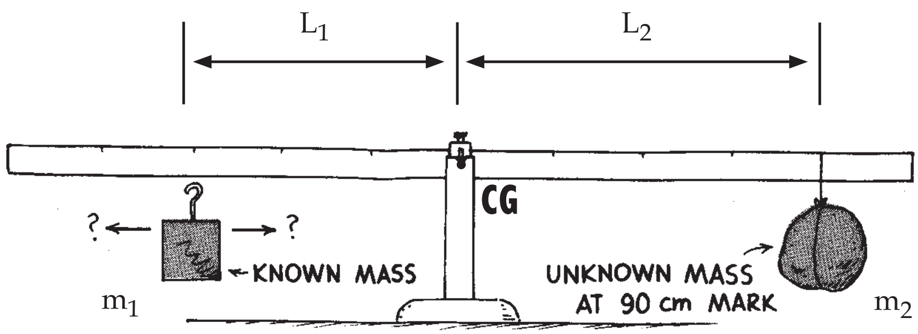
Procedure: Part A

1. Find the balance point of the meterstick. Record the balance point the CG (center of gravity) of the meterstick.

   Location of meter stick's CG: ____________ m

2. Suspended from it's CG. Attach an object of unknown mass (m_2) at the .90 m mark (L_2) of the meterstick, as shown in Figure A. Place a 0.5 kg mass (m_1) on the other side of the meterstick and bring it to a balance. Record the location of the known mass (m_1) as (L_1).

Fig. A



Position of unknown mass from the fulcrum: ______________ m (L_2)

Position of 0.5 kg mass from the fulcrum: ______________ m (L_1)

3. Calculate the mass of the unknown object using the equation for balanced torque. When an object is in balance the sum of all the torque on the system is equal to zero. Torque is equal to the force times the distance the force is applied for a fulcrum (show your work).

Equation for torque

$$\tau_{cw} = \tau_{cc} \longrightarrow m_1 l_1 = m_2 l_2 \longrightarrow \boxed{m_2 = \frac{m_1 l_1}{l_2}}$$

Solve for the unknown mass (m_2)

Calculated mass of the unknown mass: ______________ kg (m_2)

4. Find the actual mass of the unknown m_2, using a triple beam balance and record bellow. Calculate the percentage difference.

Actual mass of the unknown mass: ______________ kg (m_2)

$$Percent\ Error = \left(\frac{calculated\ mass\ -\ actaul\ mass}{actaul\ mass}\right) x100$$

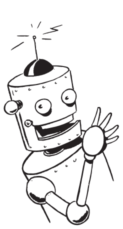
Percent error: ______________ %

5. Repeat steps 2-4 using a 1.0 kg mass.

Position of unknown mass from the fulcrum: ______________ m (L_2)

Position of 1.0 kg mass from the fulcrum: ______________ m (L_1)

6. Calculate the mass of the unknown object using the equation above. (Show your work)



Calculated mass of the unknown mass: ______________ kg (m_2)

Percent error: ______________ %

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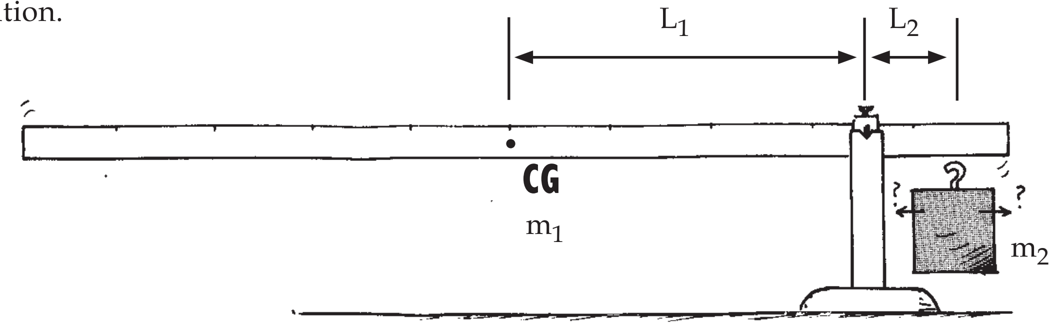
Procedure: Part B

7. Place the fulcrum exactly at the .85 m mark.

8. Balance the meterstick using a single mass hung any where between the .85 m and 1.0 m marks, as in Figure B. Record the mass used and its position.

Fig. B



Position of the 0.5 kg mass from fulcrum: __________ m (L_2)

9. The mass of the meter stick is effectively located at it's CG. Record the distance from the balance point to meter sticks CG found in the first part of this lab.

Distance from metersticks CG to fulcrum: __________ m (L_1)

10. Calculate the mass of the meter stick using the formula bellow (show your work):

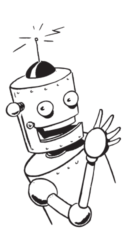
$$t_{cw} = t_{cc} \longrightarrow m_1 l_1 = m_2 l_2 \longrightarrow \boxed{m_1 = \frac{m_2 l_2}{l_1}}$$

Solve for the mass of the meterstick (m_1)

Calculated mass of meterstick: __________ kg (m_1)

11. Calculate the percentage error between the calculated and actaul mass.

$$Percent\ Error = \left(\frac{calculated\ mass\ -\ actaul\ mass}{actaul\ mass}\right) x100$$



Percent error: __________ %

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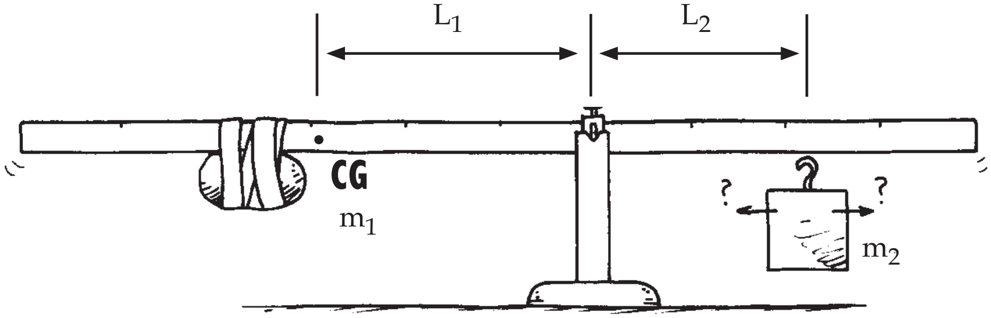
Procedure: Part C

12. Use masking tape, attach an unknown mass to the meterstick at the 0.2-m mark. Move the fulcrum to the 0.6-m mark, as shown in Figure C. Hang a known mass (0.5 kg or 1.0 kg) between the 0.6-m and 1.0-m mark to balance the meterstick. Record the mass used and its position.

Fig. C



Position of known mass (m_2) from fulcrum: __________ m (L_2)

Mass of the known mass (0.5 kg or 1.0 kg): __________ kg (m_2)

13. Find the mass of the meterstick rock combination with a triple beam balance.

Actual mass of meterstick with rock: __________ kg (m_1)

14. Calculate the location of the new CG using the formula bellow:

$$t_{cw} = t_{cc} \longrightarrow m_1 l_1 = m_2 l_2 \longrightarrow \boxed{l_1 = \frac{m_2 l_2}{m_1}}$$

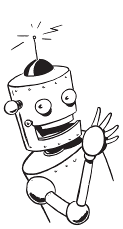
Calculated location of combined CG : __________ m (L_1)

15. Find the actual balancing point CG for the meterstick and rock and then record bellow.

Actual position of combined CG: __________ m (L_1)

16. Compare the actual location of the CG with the calculated CG and calculate the percentage difference.

$$Percent\ Error = \left(\frac{calculated\ location\ -\ actaul\ location}{actaul\ location}\right) x100$$



Percent error: __________ %