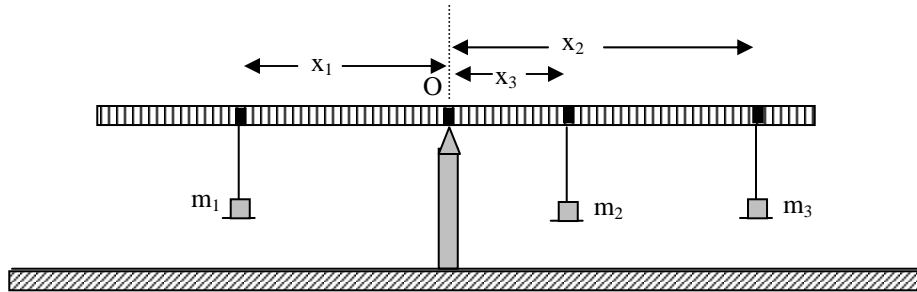


Balanced Torques and Center of Gravity

Purpose: To investigate the conditions for rotational equilibrium of a rigid bar and to determine the center of gravity of a system of masses.

Equipment: Meter stick, meter stick clamps (knife edge clamp), balance support, mass set, weight hangers, unknown masses, balance.

Introduction: The condition for rotational equilibrium is that the net torque on an object about some point in the body, O , is zero. Remember that the torque is defined as the force times the lever arm of the force with respect to the chosen point O . The lever arm is the perpendicular distance from O to the line of action of the force.



Procedure:

Note: In each of the following steps, where appropriate, make a careful sketch showing the meter stick with the applied forces and mark their locations. Also, show the point, O , about which you are calculating torques.

1. Balance the meter stick in the knife edge clamp and record the position of the balance point. What point in the meter stick does this correspond to?
2. Select two *different* masses (100 grams or more each) and using the meter stick clamps and weight hangers, suspend one on each side of the meter stick support at different distances from the support. Adjust the positions so the system is balanced. Record the masses and positions. Is it necessary to include the mass of the clamps in your calculations? **EXPLAIN!** Sum the torques about your pivot point O and compare with the expected value.
3. Place the same two masses used above at different locations on the same side of the support and balance the system with a third mass on the opposite side. Record all three masses and positions. Calculate the net torque on this system about the point support and compare with the expected value.
4. Replace one of the above masses with an unknown mass. Readjust the positions of the masses until equilibrium is achieved, recording all values. Using the equilibrium condition for rotational motion, calculate the unknown mass. Measure the mass of the unknown on a balance and compare the two masses by finding the percent difference.
5. Place about 200 grams at 90 cm on the meter stick and balance the system by changing the balance point of the meter stick. From this information, calculate the mass of the meter stick. Compare this with the meter stick mass obtained from the balance. Should the clamp holding the meter stick be included as part of the mass of the meter stick? **EXPLAIN!**
6. With the 200 grams still at the 90 cm mark, *imagine* that you now position an additional 100 grams mass at the 30 cm mark on the meter stick. Calculate the position of the center of gravity of this combination (two masses and meter stick). Where should the point of support on the meter stick be to balance this system? Check your result by actually placing the 100 g at the 30 cm mark and balancing this system. Compare the calculated and experimental results.