PHYSICS LAB EXPERIMENT – 11

TORQUES AND EQUILIBRIUM

OBJECTIVE: To develop our understanding of torques, forces, and equilibrium.

APPARATUS: Meter stick, stand, knife-edge clamps, calibrated masses, and mass balances.

THEORY: You have learned the complete definition of equilibrium in the lecture portion of this course. As a reminder: *an object in equilibrium must have both a net force and a net torque equal to zero.* This lab asks you to apply that definition and your problem-solving skills to two situations.

PROCEDURE:

1. Suspend a mass (M_1) of 50 g at the 20 cm mark on a meter stick. Slide the meter stick through the knife-edge clamp until it is balanced on the stand. Record the position at which it balanced and find R_1 (distance between the fulcrum and the position of the mass M_1) in the table below.

2. Find the mass of the meter stick (m_m) by applying the conditions of equilibrium. Use the fulcrum in this situation as your axis of rotation. ***Be sure to carefully lay out your calculations*, because you will need to include them when you turn in this worksheet.**

3. Repeat the experiment with about 80 g positioned at 20 cm as before. *Remember to include the mass of the hanger in your calculations, if you used a hanger.* Calculate the mass of the meter stick for each of the hanging masses to establish consistency.

Fulcrum position (m)		
R_1 (m)		
Hanging mass (kg)		
m_m (kg)		

Mass of the meter stick according to a mass balance = _____

Average m_m from your data = _____

4. For the next step you are constructing a cantilever, which is a structure often seen in architecture, notably in Frank Lloyd Wright's designs. Here you will implement the cantilever using a meter stick and some masses. Your task is to determine the length of meter stick with a 20 g mass placed on its cantilevered end that can be supported by placing a 200 g mass on the end sitting upon the lab bench.

5. Carefully moving your meter stick with the appropriate masses attached, determine the position of the meter stick that *just barely* allows the meter stick and its masses to remain in equilibrium instead of tipping off the bench. How much of the meter stick's length is hanging off the edge of the lab bench?

   Experimentally Determined Length of unsupported meter stick = _____

6. Now that you have experimentally determined the unsupported length of the meter stick (from step 5), use the principle of equilibrium to confirm your experiment. In other words, use your knowledge about the meter stick, its mass, the 20 g mass on its suspended end, and the 200 g mass on its supported end to calculate your Step 5 result. You may assume that the normal force is applied at the edge of the lab bench.

   Calculated Theoretical Length of unsupported meter stick = _____

7. Lastly, be sure your calculations and results from each step of the procedure are clear and complete. Turn these in to your instructor along with this worksheet, and tidy your lab bench. Thanks for a good semester!

Questions:

1. A torque is the product of force and distance (lever arm). Work is also the product of force and distance. Why aren't they the same physical quantity?

2. An object is rotating with a constant angular acceleration (clockwise). What happens when a counter-clockwise torque is applied?