SAINT JOSEPH'S PREPARATORY SCHOOL
TORQUE and BALANCES
January, 2012

NAME: ____ DATE: _______ PERIODS: ____
COLLABORATORS: ____
DATE REPORT IS DUE: _____________________________________

Introduction:

Balances are used to measure mass by comparing two things and adjusting one of them until they are equal. At first, it seems that masses are compared since that is what is measured. Equal arm balances do, in fact, require that the masses on each pan be the same in most cases. Triple beam balances clearly do not use equal masses to produce equilibrium (balance). It might seem that weight is what is compared since most balances do not work without gravity. This, however, still does not explain the triple beam balance.

In fact, *a balance balances* ***torque***. The unknown mass has weight that produces a torque acting on the beam of the balance. The known weights are moved until the torques that they produce cause ***rotational equilibrium***.

In this exercise, you will make a balance and use it to measure the mass of an unknown object. In addition, you will use the same principals to find the center of mass of a non-uniform object that you will construct.

Materials and equipment:

- meter stick
- a meter stick balance support
- a few small blocks of wood
- standard masses
- three meter stick hangers
- objects with unknown mass (washers)
- one or two small C-clamps
- a triple beam balance

Procedure:

1. With nothing hanging on the meter stick, balance it and determine the location of its center of mass (gravity). ____________________
2. With the meter stick supported at its center of mass, hang an unknown mass at the 90 cm mark and a known mass at whatever location will produce equilibrium. Record all known masses and the locations of both known and unknown masses. The mass of each thing includes the mass of the hanger that attaches it to the meter stick. Calculate the mass of the unknown and its hanger. Measure the mass of the unknown on a triple beam balance and calculate the percent error.
   - Location of known mass: ___________________________
   - Known mass: ___________________________
   - Location of unknown: ___________________________
   - Mass of unknown (experiment): ___________________________
   - Mass of unknown (balance): ___________________________
   - Percent error: ___________________________

3. Support the meter stick at the 85 cm mark and balance the meter stick with a single mass hung between the support and the 100 cm mark. Record the mass (include the hanger) used to balance the meter stick and the position of this mass. Calculate the mass of the meter stick using the location of its center of mass from step 1. Measure the mass of the meter stick and calculate the percent error of the calculated value.
    - Location of known mass: ______________________________
    - Known mass: ______________________________
    - Mass of meter stick (experiment): ______________________________
    - Mass of meter stick (balance): ______________________________
    - Percent error: ______________________________
4. Most common objects are made by combining other smaller objects. You will combine the metere stick with one or two small C-clamps to produce a new object with a new center of mass. Put one or two C-clamps on the meter stick between the end and the 50 cm mark. Measure the mass of this "object" on the balance and record it below. This is the object whose center of mass is to be measured. Support the object (meter stick with clamp(s) attached) at the 60 cm mark and use a known mass to determine the new center of mass. Support the object at the new center of mass and verify your determination.
    - Mass of object: ______________________________
    - Location of known mass: ______________________________
    - Known mass: ______________________________
    - New Center of mass: ______________________________
5. Observe the zero adjust on a triple beam balance and use it to adjust the balance properly. Describe how the zero adjust works on the triple beam balances in the lab.
6. Is it necessary for the meter stick be horizontal when it is in equilibrium? Explain.

Analysis:

Each of the six parts must be addressed individually and there must be a single conclusion that ties the parts together. **<u>All analysis must be done in the context of torque.</u>**