# Physics Lab
## Torque

Name: _____

Torque = radius **x** force

**Introduction**: A torque is a result of a force acting at a distance from an axis of rotation. It is determined by the magnitude of the force cross the length of the lever arm. For example, if a force is exerted on a lever at some angle other than 90 degrees, only the perpendicular component of the force can be considered when calculating the value of the torque produced. In this lab all forces will be acting at right angles to the lever and the torque is simply the length of the lever arm times the force. The appropriate unit of torque is the newton·meter but we will use gram·centimeters in order to speed the calculations. Be certain to include the mass of the hangers when doing your calculations. When a system is not rotating or rotating at a constant speed, it is said to be in rotational equilibrium. For a system in rotational equilibrium, the sum of the clockwise torque must equal the sum of the counterclockwise torque.

Torque cw = Torque ccw

## Initial Instructions:

1. Measure the mass of three mass hangers and record each one separately. Write the mass on the hanger in pencil so that you will be able to use the exact mass for your calculations. Mass of hanger 1 _____
hanger 2 _____ hanger 3 _____

3. Find the balance point of the meter stick and record. _____
When calculating the length of the lever all positions will need to be compared with this balance point.

## Part A.

1. Place a 100 gram mass at the 10 cm. mark. Calculate the torque exerted by this mass. _____ _____

2. Place a 200 gram mass at the appropriate place in order to balance the system. Record the position. _____
Calculate the length of the lever arm. _____

3. Calculate the torque exerted by the 200 gram mass. _____

4. Calculate the percent difference between the two torque values. Use the 100 gram mass as the actual. _____

## Part B.

1. Place a 100 gram mass at the 40 cm. mark and a 50 gram mass at the 30 cm. mark. Calculate the sum of the torque exerted by these two masses.
_____

2. Place a 200 gram mass at the appropriate place to balance the system. Record the position. _____
Calculate the length of the lever arm. _____

3. Calculate the torque exerted by the 200 gram mass. _____

4. Compute the percent difference between the two torque values using the 100 and the 50 gram mass side as the actual. _____

## Part C.

1. Place an unknown mass at the 20 cm. mark.

2. Place an appropriate known mass on the opposite side in order to balance the unknown mass. Record the position of this mass. _____
Calculate the length of the lever arm. _____

3. Calculate the torque exerted by the known mass. _____

4. Calculate the mass of the unknown. Be sure to subtract the mass of the hanger. Show work in the space below.

5. Measure the mass of the unknown using the balance. _____

6. Calculate the percent difference between the two mass values using the value from the balance as the actual. _____

## Part D.

1. Place the fulcrum of the meter stick at the 30 cm. mark.

2. Place an appropriate mass in order to balance the system. Record the magnitude of the appropriate mass. _____
Record the position of the appropriate mass. _____
Calculate the length of the lever arm. _____

3. Calculate the torque exerted by this mass. _____

4. Calculate the mass of the meter stick. (Hint: the entire mass of the meter stick can be thought of as acting at the old center of balance.) Show calculation in the space below.

calculated mass of meter stick = _____

5. Measure the mass of the meter stick using the balance. (Remove the knife edge clamp.) _____

6. Calculate the percent difference between the two values using the value from the balance as the actual. _____

7. Question: Why could the mass of the meter stick be ignored in parts A,B, and C but not in part D? _____
_____
_____
_____

8. Repeat the calculation for part D this time dividing the ruler up into two sections. One section will have 70 % of the entire mass of the ruler and be centered at the 65 cm mark, the other section will contain 30 % of the entire mass of the ruler and be centered at the 15 cm mark. Show work and answer below.

calculated mass of meter stick = _____

9. Your answer in step 8 was probably close to but perhaps not in perfect agreement with your answer for the mass of the ruler from step 4. What would explain this difference if any? _____

_____

_____

_____

10. Write a summary of the physical laws that you learned as a result of this study.

11. Suppose you are at a park with two children of unequal mass who are having difficulty on the seesaw, how would this study enable you to help them solve their problem?

12. Search the internet for the price of a good torque wrench and list below. What unit is the torque wrench calibrated in? Now search the internet for the torque specifications for the head gasket bolts on a 2012 Ford F-150.