**Name:**

**Lab Partners:**

**Course: AP Physics**

**Period:**

**Date:**

**AP Lab #8 - Torque**

**Purpose/Problem:** To determine the sum of the clockwise and counterclockwise torques about a given axis of rotation for a system that is in rotational equilibrium.

**Hypothesis:** The sum of the clockwise and counterclockwise torques about a given axis of rotation for a system that is in rotational equilibrium will be equal to*…(finish this sentence).*

**Materials:** Meter stick, two 5N or 10N spring scales, three lengths of string,

500 g hooked mass, ring stand with horizontal crossbar and clamp

**Experimental Design & Procedure:**

1. Hang each of the spring scales from the pendulum clamp on each of the ring stands. Zero the spring scales *while nothing is hanging from them*.
2. Tie the lengths of string into uniform loops.
Then set up the apparatus as illustrated below:

 A C

 B

1. (a) Hang the first clamp on one of the spring scales and attach it at the 5.0 cm

 mark to the meter stick (these will be henceforth referred to as **String A** &

 **Spring Scale A**).

(b) Center the second clamp at the 50.0 cm mark on the meter stick and connect it

 to the 500 g mass (this will be henceforth referred to as **String B**).

1. Hang the third clamp on the other spring scale and attach it at the 95 cm mark

 to the meter stick (these will be henceforth referred to as **String C** & **Spring**

 **Scale C**).

1. Note carefully the readings on both spring scales. Then take the 500 g hooked mass off its clamp and again carefully note the readings of both scales. Calculate the DIFFERENCE of the reading on each scale before and after the mass is removed and record each difference in the appropriate places in the data table.
2. Record the distance from **String A** to **String B** and the distance from **String B** to **String C**. The center of **String B** will serve as the "axis of rotation" or pivot point in this lab.
3. Repeat Steps #3 through #5 for Trials #2 through #5, moving **String A** and/or **String B** to different positions on the meter stick. The meter stick must be horizontal at all times and the clamps must be vertical at all times. Therefore, it may be necessary to move the ring stands or to raise or lower the pendulum clamps when the C-clamps are moved to different positions to maintain the horizontal orientation of the meter stick.

**Observations & Data:**

 **Clockwise Torque Counterclockwise Torque**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Trial | Difference in **Scale A** Force Reading (N) | Distance from**String A**to **String B**(m) | Difference in **Scale C** Force Reading (N) | Distance from**String B** to**String C**(m) |
| 1 |  |  |  |  |
| 2 |  |  |  |  |
| 3 |  |  |  |  |
| 4 |  |  |  |  |
| 5 |  |  |  |  |

**Analysis:**

1. Show all of the calculations (here) to determine the *magnitudes* (remember, the word “magnitude” means the “absolute value” of or the “size” of the quantity—a “magnitude” can’t be negative and it doesn’t include direction) of the clockwise and counterclockwise torques for each trial. Remember to treat the center of **String B** as the pivot point/ axis of rotation.
2. Compare the magnitudes (again, the word “magnitude” means the “absolute value” of or the “size” of the quantity—a “magnitude” can’t be negative and it doesn’t include direction) of the clockwise and counterclockwise torques for *each* trial with a percent difference calculation (show the equation used each time and treat the counterclockwise torque as the “most trusted value” for consistency even though they are really equally trustable since they are both experimentally obtained).
3. Calculate the sum of the clockwise and counterclockwise torques for each trial. Show your work here and now be careful to include the appropriate signs (+ or -) for each as you sum them.
4. How much work is done by the torques in each trial? Justify this answer (and include the question as always in your write-up.
5. Add the force readings of **Scale A** and **Scale C** for each trial. Show your work here. Use subscripts. How does the *average* of these sums compare to the weight of the 500 g mass (with a percent difference calculation including equation)?

**Conclusion:**

1. Relate the results of your analysis to your hypothesis. What is true? What did you learn (or confirm) about the world?
2. Now that you have studied *Newton's 2nd Law* **and** *torque*, what *two* truths can you definitively affirm regarding the sum of the forces and the sum of the torques for systems in rotational equilibrium?