Name: ____________________ Section: __________ Date: ______________

Datasheet - Exp 10: Moments of Inertia

Objective

To determine the moment of inertia of a rotating system, alter the system, and accurately predict the new moment of inertia .

Theory

Moment of Inertia (I) can be understood as the rotational analog of *mass*. **Torque** (τ) and **angular acceleration** (α) are the rotational analogs of *force* and *acceleration*, respectively.

Thus, in rotational motion, Newton's Second Law: $F = ma$ becomes: $\tau = I\alpha$.

PROCEDURE

Part 1: Moment of Inertia of apparatus with no additional masses.

1. Using the vernier caliper, measure the diameter of the axle around which the string wraps. Calculate the radius of the axle.
2. Holding the disk, place 50 grams (mass hangers are 50 grams) on the string. Measure the distance from the bottom of the mass hanger to the floor.
3. Release the disk, *be sure not to impart an initial angular velocity*. Using the stopwatch, measure the time until the mass hanger reaches the floor.
4. Repeat *Step 3* five times. Record the times in a table and calculate the average time.
5. Using the average time, calculate the **linear acceleration (a)** of the masses with the kinematic equation.
6. Calculate the **angular acceleration (α)** of the disk using $\alpha = \frac{a}{r}$. Refer to *Step 1* for r.
7. Calculate the **tension (T)** on the string, Eq. 9.4. (The total force (ma) is equal to the force of gravity minus tension).
8. The applied torque on the spinning disk is provided by the tension of the string. Use the values from *Step 7* and the radius of the axle to calculate the **torque (τ)**.
9. Repeat *Step 2* through *Step 8* for **100 grams** on the mass hanger in addition to the mass from *Step 1*.
10. Using *Graphical Analysis*, plot the net torque vs. angular acceleration for both situations. **Be sure to enter the origin as a data point**. Determine the moment of inertia of the disk, I_0.

Part 2: Moment of Inertia of apparatus with additional masses.

11. Measure the distance from the center of the disk to the outer set of tapped holes (Where you will attach the three large masses).
12. Attach the three masses to the disk. These masses are 1.35kg each. Calculate the new moment of inertia, I_{new}, for the system (you may treat the added masses as point masses, use I_0 from part 1).
13. Repeat *Step 2* through *Step 10* for the altered system. Calculate the percent difference between the experimental value and the theoretical (calculated) value.

You should have 2 graphs to include in your lab report.

When determining independent and dependent and variables, consider what you changed between Part 1 and Part 2.

D_{axle}:__________________

r_{axle}:__________________

y_{floor}:__________________

R_{masses}:__________________

Raw data:

Trial	t-Part 1(a) (s)	t-Part 1(b) (s)	t-Part 2(a) (s)	t-Part 2(b) (s)
1				
2				
3				
4				
5				
Average				

Calculated Data:

	Part 1(a)	Part 1(b)	Part 2(a)	Part 2(b)
a				
α				
T				
τ				

(Be sure to include units in your lab report!)

Experimental I_0:__________________
(Use this to calculate Theoretical I_{new})

Theoretical I_{new}:__________________

Experimental I_{new}:__________________

Percent Difference I_{new}:__________________

Questions

1. What are the units for **Torque, Moment of Inertia,** and **Angular Acceleration**? Show all work.
2. If the Torque applied to a rigid body is doubled, what happens to the Moment of Inertia?
3. Why did you need to calculate acceleration to determine I_0? Could you have calculated a theoretical I_0 without running any trials?
4. Were any torques ignored in this experiment? What are they? Do you believe they may have significantly altered your results?