Name: _____ Date:_____

Dr. Croom's Physics Lab 11-3

Moment of Inertia [NOTEBOOK LAB]

Purpose

To measure the moment of inertia for the provided items.

Equipment

1. Rotational motion apparatus, consisting of a main disk and drum, base plate with bearing and shaft, auxiliary disk, steel ring, and rectangular plate
2. smart pulley and table edge clamp
3. Science Workshop interface
4. Weight hanger with 50- and 100-g weights
5. Stopwatch or stop clock
6. Meter stick
7. Vernier calipers
8. Triple-beam balance
9. Level
10. String

Proceed

Note: Creating the tables in Excel with the correct formulas will speed up your calculations and data collection

Calculated Moment of inertia I for the main disk, auxiliary disk and the ring.

1. Measure the mass of the main disk and the radius. Record.
2. Calculate the moment of inertia for the main disk based on **$I=1/2MR^2$** record your answers in table 1
3. Calculate the moment of inertia for the auxiliary disk based on **$I=1/2MR^2$** record your answers in table 1
4. Calculate the moment of inertia for the ring based on **$I=MR^2$** record your answers in table 1
5. Record the moment of inertia for the main disk in table 3
6. Calculate the moment of inertia for main disk and auxiliary disk by adding together the moment of inertia of the auxiliary and main disk record your answers in table 3
7. Calculate the moment of inertia for main disk and ring by adding together the main disk and the ring record your answers in table 3

Experimental moment of inertia

8. Set up data studio as follows
    - Open
    - Click smart Pulley
    - **Select position ch 1 and velocity ch1**
    - Click on constants
    - If you have a 3 spoke pulley Set arc length at .05 and spoke angle 120^0 for the three spoke smart pulley. If you have the black 10 spoke pulley do not change the settings.
    - To set auto stop, click sampling options
    - click auto stop
    - click data measurement
    - change from velocity ch 1 to position ch 1
    - change to is above
    - set .28 m and click ok.
    - Set up velocity time graph as follows: (Remember the slope is the acceleration)
        a. Under displays click on graph
        b. Click on velocity ch 1
        c. Click anywhere on graph to get graph setting
        d. Now click on axis settings
        e. Set both x and y minimum at 0 and x maximum at 4 seconds

f. You are now ready to start the experiment

9. Wind up the string on the large step pulley under the main disk.
10. Place 100 g mass on a mass hanger.
11. Make sure the step pulley is aligned with the smart pulley by making sure the string runs horizontal.
12. Place the string over the smart pulley and then hold the disk to prevent the string from unwinding.
13. Start the program and release the disk so the pulley will unwind.
14. The autostop will turn of the program
15. The slope of the velocity time graph you get will be the tangential acceleration of the disk.
16. To get the slope of the graph click on fit and then linear. This will displace the slope of the line. Record the Acceleration in table 2.
17. Repeat 4 more times. Take the average.
18. Repeat step 16 and 17 using the main disk and the auxiliary disk.
19. Repeat step 16 and 17 using the main disk and the hoop.
20. This lab will not be done using the computer. It will be done on notebook paper long hand.
21. Calculate the force on the step pulley as follows and record it in table 3.
    - Use Equation 1 based on Newton's second law,

$$ma = F_{applied} - F_{tension}$$

$F_{applied}$ is the weight on the pulley (mg)
$F_{tension}$ is the force on the step pulley. The force we use to calculate torque.

Rearrange the above equation.

$$\mathbf{F_{tension} = mg - ma.}$$

m is the hanging mass. Include the mass of the mass hanger (5 g) if present.
a is the acceleration you measured.

22. Calculate the torque on the pulley and record it in table 3.

$$\boldsymbol{\tau}\textbf{ = force x distance}$$

$$\text{Force} = F_{tension}$$

distance = radius of the step pulley = .025m.
Measure it with vernier calipers to verify this value.

23. Calculate angular acceleration (α) record in table 3.

$$a = \alpha r \quad \text{so} \quad \boldsymbol{\alpha = a/r}$$

r of the step pulley

24. Calculate the moment of inertia record in table 3.

$$\tau = I\alpha \quad \mathbf{I = \tau/\alpha}$$

This is the experimental I.

25. Calculate the percent error between the calculated moment of inertial and the experimental moment of inertial Record in table 4

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DATA TABLES

TABLE 1 (Calculated Moment of Inertia)			
Item	**mass (kg)**	**radius (m)**	**Calculated Moment of Inertia ($kg\ m^2$)**
Main disk			
auxiliary disk			
ring			

Table 2 (Accelerations)			
Trial	**Main disk (m/s^2)**	**Main disk + auxiliary (m/s^2)**	**Main disk + ring (m/s^2)**
1			
2			
3			
4			
5			
Average=			

Table 3 (Experimental Moment of Inertia)						
Item	**Calculated Moment of Inertia ($kg\ m^2$)**	**Acceleration from slope (m/s^2)**	**Tension F_t (N)**	**Torque τ (Nm)**	**Angular Acceleration α (rad/s^2)**	**Experimental Moment of Inertia ($kg\ m^2$)**
Main disk						
main +auxiliary						
main + ring						

Table 4 (Errors)			
Item	**Calculated Moment of Inertia ($kg\ m^2$)**	**Experimental Moment of Inertia ($kg\ m^2$)**	**error (%)**
Main disk			
main +auxiliary			
main + ring			

Questions/Things you need to do individually:

Purpose (5pt)

Include

Data (10pt)

Print and attach the data tables into your notebook.

Calculations (10 pt)

Show an example of each of the calculations to show how to calculate the moment of inertia for one of the trials.

Error Analysis (10pt)

Write a strong error analysis section

Results (10pt)

Explain the result. Make sure you include how they relate to the purpose of this lab.