Rotational Inertia

Name____________________________________TA____________________________________

Partners____

Section#________________________________Date___________________________________

This lab is case sensitive. Please do not mix up R and r, and M and m.

1. Moment of Inertia of Apparatus

Shaft diameter D_________________ (cm)÷100→______________________ (m)

Shaft radius r =D/2______________________________________(m)

Distance between photo gates, h _________________(cm)÷100→______________________(m)

Hanging mass, m ___________0.200___________ (kg)

Gravitational acceleration, g ______9.81________ (m / s^2)

Trial #	t	$a = 2h/t^2$	$I_A = m r^2 (g - a)/a$
1			
2			
3			
4			

Average and standard deviation I_A = (±) $kg \cdot m^2$

2. Moments of Inertia of Various Objects

- Preparation

The diameter of Disk and Ring is supposed to be the same. Just make sure about that, and measure the diameter of Disk 3 times by different person.

Diameter { ____________________(m)
____________________(m)
____________________(m)

Average diameter _______________(m)

Radius (Disk or Ring) R =Ave. diameter÷2__________________________(m)

- Object 1: Disk

➢Theoretical value of the moment of inertia

The labeled mass M_____________________________(kg)

Theoretical $I_{disk} = ½ M R^2 =$ ____ $(kg \cdot m^2)$ **(1)**

➢Experimental value of the moment of inertia

Falling times
_____________________(s)
_____________________(s)
_____________________(s)

Average t	$a = 2h / t^2$	$I_{total} = m r^2 (g - a) / a$

Experimental $I_{disk} = I_{total} - I_A =$ ____ $(kg \cdot m^2)$ **(2)**

Question:
How well does the measured moment of inertia agree with the calculated (theoretical) one [(**1**) & (**2**)]? If you obtained less than 5 % error with taking the standard deviation into account, it would be a very good result.

- Object 2: Ring

➢Theoretical value of the moment of inertia

The labeled mass M_____________________________(kg)

Theoretical $I_{ring} = M R^2 =$ ____ $(kg \cdot m^2)$ **(3)**

➢Experimental value of the moment of inertia

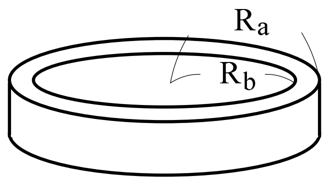
Falling times
_____________________(s)
_____________________(s)
_____________________(s)

Average t	$a = 2h / t^2$	$I_{total} = m r^2 (g - a) / a$

Experimental $I_{ring} = I_{total} - I_A =$ ____ $(kg \cdot m^2)$ **(4)**

Question:
Supposedly, the experimental value **(4)** would agree with the theoretical one **(3)**. However, you likely obtain a less value in experiment than that in theory (The theoretical value is always bigger!). You can think about this qualitatively. You should discuss it with the following question: Is the shape of object (Ring) exactly matched with the theoretically ideal object? (***Please go to next page!***)

❄ If the thickness of the ring is very thin, you can use $MR^2/2$ for the moment of inertia. However, if you have to consider the thickness, you will use following:



$$I = \frac{1}{2}\left(R_a^2 + R_b^2\right)M$$

Now, measure R_a and R_b, then calculate the above moment of inertia.

R_a _______________ (m); R_b _______________ (m); Labeled Mass ______________(kg)

$I = \frac{1}{2}\left(R_a^2 + R_b^2\right)M$ = ___________________________________ ($kg \cdot m^2$) **(5)**

Question:

How well does the measured moment of inertia agree with the calculated (theoretical) one [**(4)** & **(5)**]?

Lab Procedure for Rotational Inertia

Part 1. Moment of Inertia of Apparatus

1. **Find the shaft diameter; then calculate the radius.**

By using caliper, measure the diameter of the axis of apparatus. You should take three significant figures (ex. 0.0467 m). Dividing it by 2, you will obtain the radius, r.

2. **Measure the distance between photo gates.**

With a meter stick, measure the distance, h. The unit has to be meter.

3. **Take a sufficient length of string, and reel it around the shaft.**

The length should be more than 1 meter. Just hook the string at the shaft, and reel it up.

4. **Make sure the position of each device.**

Pulley, photo gates, and moment of inertia apparatus should be located appropriately. The string from the apparatus should be parallel with pulley. And the apparatus must be put on far from the pulley. If you are not sure about this, please ask TA.

5. **Hook a hanging mass at the other end of string; then record the falling time, t, with Science Workshop.**

The hanging mass is 0.2 kg (200 g). You have to use 0.2 kg through this lab. As usual, it must be as close to the first gate as possible before the release.

6. **Calculate the acceleration and the moment of inertia of apparatus.**

The final result should be the average ± the standard deviation.

Part 2. Moments of Inertia of Various Objects

1. **Measure the diameter of the objects** (Disk and Ring), **and obtain the radius.**

The measurement should be taken three times by different person, and obtain the average.

2. **Calculate the theoretical values of moments of inertia** (Disk and Ring)**.**

You can use the labeled mass to calculate them. To obtain them, just plug in the given formulae.

3. **Record the falling time intervals for three times** (for both Disk & Ring)**.**

You can just measure the intervals for three times consecutively. And obtain the average. But if you get a very off result, you will neglect it, and calculate the average from the rest of two values.

4. **Obtain the experimental values for the moments of inertia** (for both Disk & Ring)**.**

This is almost the same procedure as in part 1. Do not be confused by the variables, r and R. You have to use ‘r’, which is shaft radius, to calculate these. I_A is from part 1.

⏩NOTE:

* For part 2, you will NOT use the objects “Disk” and “Ring” at the same time.

* Through this lab (part 1 & 2), r is shaft radius; R is the radius of an object; m is hanging mass (0.2 kg); and M is the mass of an object at any time.