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PHY 133 Section L05
Lab 7: Angular Momentum
Experiment performed on 4/8/29 with Victor Roy
Report submitted on April 15, 2019

Introduction

The goal of the lab is to observe the conservation of angular momentum. My partner and I reviewed different concepts of angular momentum. We measured the frictional torque as well as the hanging torque. Which was measured through the use of a photogate and a spinning apparatus. The spinning apparatus was attached to a mass then spinned for the first step. For the second step a mass was dropped upon the spinning and the photogate connected to the computer measured the platform momentum inertia. The initial angle momentum was found in the second part as well as the final angular momentum. Then we tested whether their was conservation of angular momentum through the information gathered.

Data Table

Part I

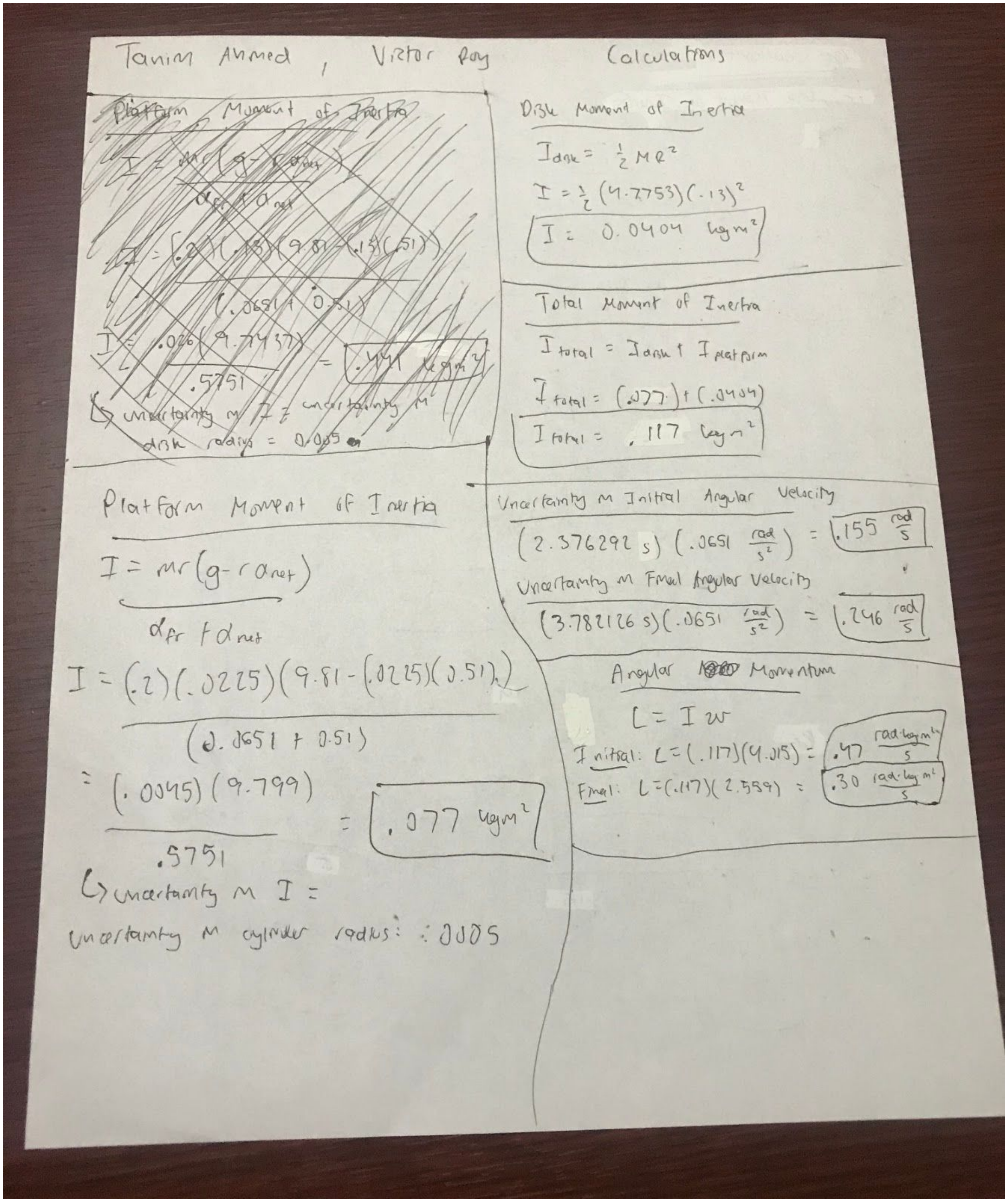
Quantity	α(fr)	α(net)	Hanging mass, m	Cylinder radius, r	g	Platform Mom. Inertia
Unit	rad/s^2	rad/s^2	kg	m	m/s^2	kg*m^2
Value	0.0651	0.51	0.2	0.0225	9.81	0.077
Uncertainty				0.0005		0.0005

Part II

Quantity	Disk mass, M	Disk radius, R	Disk Mom. Inertia	Total Mom. Inertia	Initial Ang. Vel.	Final Ang. Vel.	Initial Ang. Mom.	Final Ang. Mom.
Unit	kg	m	kg*m^2	kg*m^2	rad/s	rad/s	rad*kg*m^2/s	rad*kg*m^2/s
Value	4.7753	0.13	0.0404	0.117	4.015	2.559	0.47	0.3
Uncertainty	0.001	0.005	0.0031	0.00314	0.155	0.246	0.022	0.03

Was angular momentum conserved, to within uncertainty?	No

Calculations



Tanim Ahmed , Victor Roy   Calculations

~~Platform Moment of Inertia~~

~~$I = \frac{mr(g - r\alpha_{net})}{\alpha_{fr} + \alpha_{net}}$~~

~~$I = \frac{(.2)(.13)(9.81 - (.13)(.51))}{(.0651 + 0.51)}$~~

~~$I = \frac{.026(9.7437)}{.5751} = \boxed{.441 \text{ kgm}^2}$~~

~~↳ uncertainty in I = uncertainty in disk radius = 0.005~~

Disk Moment of Inertia

$I_{disk} = \frac{1}{2} MR^2$

$I = \frac{1}{2}(4.7753)(.13)^2$

$\boxed{I = 0.0404 \text{ kgm}^2}$

Total Moment of Inertia

$I_{total} = I_{disk} + I_{platform}$

$I_{total} = (.077) + (.0404)$

$\boxed{I_{total} = .117 \text{ kgm}^2}$

Platform Moment of Inertia

$I = \frac{mr(g - r\alpha_{net})}{\alpha_{fr} + \alpha_{net}}$

$I = \frac{(.2)(.0225)(9.81 - (.0225)(0.51))}{(0.0651 + 0.51)}$

$= \frac{(.0045)(9.799)}{.5751} = \boxed{.077 \text{ kgm}^2}$

↳ uncertainty in I =

uncertainty in cylinder radius: .0005

Uncertainty in Initial Angular Velocity

$(2.376292 \text{ s})(.0651 \frac{rad}{s^2}) = \boxed{.155 \frac{rad}{s}}$

Uncertainty in Final Angular Velocity

$(3.782126 \text{ s})(.0651 \frac{rad}{s^2}) = \boxed{.246 \frac{rad}{s}}$

Angular Momentum

$L = I\omega$

Initial: $L = (.117)(4.015) = \boxed{.47 \frac{rad \cdot kg\,m^2}{s}}$

Final: $L = (.117)(2.559) = \boxed{.30 \frac{rad \cdot kg\,m^2}{s}}$

Uncertainty in Disk Moment of Inertia:

$I_{disk} = \frac{1}{2}MR^2 = \frac{1}{2}(4.7753)(0.13)^2 = 0.0404\ kg\,m^2$

$\sigma(R^2) = 2|R|^1\sigma(R)$

$\sigma(.13)^2 = 2(.13)(.005) = \boxed{.0013} \longrightarrow \sigma(R^2)$

$\sigma(M\cdot R^2) = |M\cdot R^2|\sqrt{\left(\frac{\sigma M}{M}\right)^2+\left(\frac{\sigma R^2}{R^2}\right)^2}$

$\sigma(4.7753\cdot(.13)^2) = |.0807|\sqrt{\left(\frac{.001}{4.7753}\right)^2+\left(\frac{.0013}{.0169}\right)^2}$

$= (.0807)(.0769) = \boxed{0.0062} \longrightarrow \sigma(M\cdot R^2)$

$\sigma\left(\left(\frac{1}{2}\right)(MR^2)\right) = |\tfrac{1}{2}|\sigma(MR^2)$

$= \frac{1}{2}(.0062) = \boxed{0.0031} \longrightarrow \sigma(\tfrac{1}{2}MR^2)$

Uncertainty in Total Moment of Inertia

$I_{total} = I_{platform} + I_{disk} = (.077)+(.0404) = .117\ kg\,m^2$

$\sigma(A+B) = \sqrt{\sigma_A^2+\sigma_B^2}$

$= \sqrt{(.0005)^2+(.0031)^2} = \boxed{0.00314}$

Uncertainty in Angular Momentum $(L = I\omega)$

Initial: $L = (.117)(4.015) = .47$

Final: $L = (.117)(2.559) = 0.3$

$\sigma(A\cdot B) = |AB|\sqrt{\left(\frac{\sigma A}{A}\right)^2+\left(\frac{\sigma B}{B}\right)^2}$

$= |.47|\sqrt{\left(\frac{.00314}{.117}\right)^2+\left(\frac{.155}{4.015}\right)^2}$

$= (.47)(.047)$

$= \boxed{0.022}$

$\sigma(.117\times 2.559) \rightarrow$ multiplication

$= |0.3|\sqrt{\left(\frac{.00314}{.117}\right)^2+\left(\frac{.246}{2.559}\right)^2}$

$= (0.3)(0.0998)$

$= \boxed{0.03}$

Results

Overall, based on our data collected, angular momentum was not conserved, since initial and final angular momentum were not the same within uncertainty. This is probably due to there being friction opposing the angular acceleration.

Conclusion

The information gathered from the photogate was used to determine whether the angular momentum was conserved. Two tests were conducted one with a spinning apparatus attached to a weight and another test where a weight was slammed on the spinning apparatus. The data was collected from the computer which was attached to the photogate. The moment of inertia was gathered and then we validated whether there was a conservation of momentum which was not the case due to friction opposing the angular acceleration.

Discussion

2. The expected impact of the handle being there is that the platform has a “radius” sticking out from it, and because of this extra length in the y direction, it causes a more drastic increase in inertia, as there is a square relationship between radius and moment of inertia. In addition, as moment of inertia increases, the final angular momentum also increases linearly.
3. If the drop was slightly off-center, we can assume that the moment of inertia of the platform+disk would be less than if the drop were perfectly centered. This is because, using the parallel axis theorem, it shows that the larger the distance your center of mass is displaced by, the lesser and lesser your new moment of inertia is.