Rotational dynamics

Identification page

Instructions: Print this page and the following ones before your lab session to prepare your lab report. Staple them together with your graphs at the end. If you forgot to print it before your lab, you can reproduce it by hand but you have to follow the exact format (same number of pages, same items on each page, same space to answer question).

Complete <u>all the identification fields below</u> or 10% of the lab value will be deduced from your final mark for this lab.

For in-lab reports, hand in your report to your demonstrator at the end of the sessions or you will receive a zero for this lab.

For take-home reports, drop your report in the right box or 10% of the lab value will be deduced from your mark. Refer to the *General information* document for the details of the late report policy.

Experiment title: Rotational dynamics ______________________

____

Name: ______________________

Student number: ______________________

Lab group number: ______________________

Course code: PHY ______________________

Demonstrator: ______________________

Date of the lab session: ______________________

Partner's name: ______________________

Data sheet

Instructions: This lab report is due at the end of the lab session. We recommend completing the *Data sheet* before starting the *Questions* section.

Part 1 – Measuring the moment of inertia

[0.5] Record the diameter of the pulley on the rotary motion sensor:

$D =$ (________________ $\pm$ ________________) m

[1] Measure the mass of the aluminum discs and the diameter of the first disc:

$M_1 =$ (________________ $\pm$ ________________) kg

$M_2 =$ (________________ $\pm$ ________________) kg

$D_1 =$ (________________ $\pm$ ________________) m

[4] Fill the following table. You do not have to report uncertainties. Keep 4 significant figures for the angular acceleration and 3 sig. figs for the torque. Use the absolute value for the angular acceleration.

Table 1 – Angular accelerations of a disc pulled by various forces

Run	Hanging mass m (kg)	Angular acceleration α (rad/s^2)	Torque $\tau = mr(g - \alpha r)$ (N·m)
Empty hook			
Hook + ≈ 0.0025 kg			
Hook + ≈ 0.0050 kg			
Hook + ≈ 0.0075 kg			
Hook + ≈ 0.0100 kg			
Hook + ≈ 0.0125 kg			

[4] Fill the following table. You do not have to report uncertainties. Keep 4 significant figures for the angular acceleration and 3 sig. figs for the torque. Use the absolute value for the angular acceleration.

Table 2 - Angular accelerations of two discs pulled by various forces

Run	Hanging mass m (kg)	Angular acceleration α (rad/s^2)	Torque $\tau = mr(g - \alpha r)$ (N·m)
Empty hook			
Hook + ≈ 0.0025 kg			
Hook + ≈ 0.0050 kg			
Hook + ≈ 0.0075 kg			
Hook + ≈ 0.0100 kg			
Hook + ≈ 0.0125 kg			

[0.5] Measure the mass of the rod-masses system:

$M_{\text{rod-masses}} = ($ ______________ $\pm$ ______________ $)$ kg

[4] Fill the following table. You do not have to report uncertainties. Keep 4 significant figures for the angular acceleration and 3 sig. figs for the torque. Use the absolute value for the angular acceleration.

Table 3 - Angular accelerations of a rod-masses system pulled by various forces

Run	Hanging mass m (kg)	Angular acceleration α (rad/s^2)	Torque $\tau = mr(g - \alpha r)$ (N·m)
Empty hook			
Hook + ≈ 0.0025 kg			
Hook + ≈ 0.0050 kg			
Hook + ≈ 0.0075 kg			
Hook + ≈ 0.0100 kg			
Hook + ≈ 0.0125 kg			

Part 2 – Conservation of angular momentum

[1] Determine the rate of change of ω before the collision:

$d\omega/dt =$ ________________

[1] Determine the angular speeds before and after the collision:

$\omega =$ ________________ $\omega' =$ ________________

[1] Determine the time interval of the collision:

$\Delta t =$ ________________

Graphs

Prepare Graph 1 for the three data sets. Submit it online before the end of the lab session. [4 points]

Prepare Graph 2 for the collision. Submit it online before the end of the lab session. [4 points]

Questions

Part 1 – Measuring the moment of inertia

[2] Based on your graph, what is the experimental moment of inertia of the first aluminum disc ($I_{1\mathrm{d}}$)? How does it compare to the one of the two discs together ($I_{2\mathrm{d}}$)? Discuss.

[2] Based on your graph, what is the experimental moment of inertia of the rod-masses system (I_{rm})? Compare it to the one of the two discs ($I_{2\mathrm{d}}$). Discuss.

[2] Calculate the moment of inertia of the first aluminum disc (in $\mathrm{kg \cdot m^2}$) using its mass and radius (and its uncertainty). Recall that the formula to calculate moment of inertia is $I = MR^2/2$.

[1] Calculate the percentage difference between theoretical value for the moment of inertia of the first disc and the one you obtained experimentally. Discuss.

Part 2 – Conservation of angular momentum

[2] Calculate the angular momentum of the discs before (L) and after (L') the collision. What is the ratio: L'/L (expressed as a percentage)? Use you experimental values for the moments of inertia.

[2] Was the angular momentum conserved? Explain.

[2] Can you use the rate of change of ω to explain a difference between L and L'? Explain.

Total : ________ / 38

(30 points for the report, 8 points for graphs)