Angular Acceleration and Moment of Inertia

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Abstract:

Introduction:

What we’re finding:

We will be varying two variables to see how they affect angular acceleration: the magnitude of the force applied and the radius at which that force is applied. These measurements will then be used to find the moment of inertia of the rotating body.

Set up:

The set up consists of a large circular plate free to rotate about a low friction vertical axis through the use a thread wound around a small pulley attached to the plate with a hanging weight attached to it. The pulley has a motion sensor to collect data. The pulley has three radii, and the magnitude of the force can be controlled by varying the mass of the hanging body.

Equations:

For the torque applied from the tension of the string

𝜏 = 𝑇­­­­­­­­­1r = 𝐼M𝛼1

T1 = 𝐼M𝛼1/r

For the tensions on both sides of the pulley due to no slippage with the string in the pulley

𝜏2 − 𝜏1 = 𝑇2𝑅 − 𝑇1𝑅 = 𝐼𝑝𝛼2

In which 𝑇2 can be determined to be negligible

Using Newton’s 2nd law

𝑚𝑔 − 𝑇2 = 𝑚𝑎2

𝑇2 = 𝑚𝑔 – 𝑚𝑎2

Substitution gives

𝑅 (𝑚𝑔 – 𝑚𝑎2 – (𝐼M𝛼1/r)) = 𝐼𝑝𝛼2

Which is solved for 𝛼2 to give

𝛼2 = 𝑔/(𝐼𝑝/ 𝑚𝑅+ 𝐼𝑀𝑅 /𝑚𝑟2 + R))

A frictional torque is also present which opposes the rotational motion

𝜏𝑇𝑂𝑇𝐴𝐿 = 𝜏 – 𝜏­ = 𝑇­𝑟 – 𝜏­ = 𝐼𝑀𝛼1

Equipment:

* PASCO Rotational Dynamics apparatus
* PASCO Rotary Motion Sensor
* Laptop computer running Logger Pro software
* LabQuest Mini interface
* Vernier calipers
* Pan/beam type balance
* Meter stick
* Threaded weight set (or hex nuts)

Procedure: