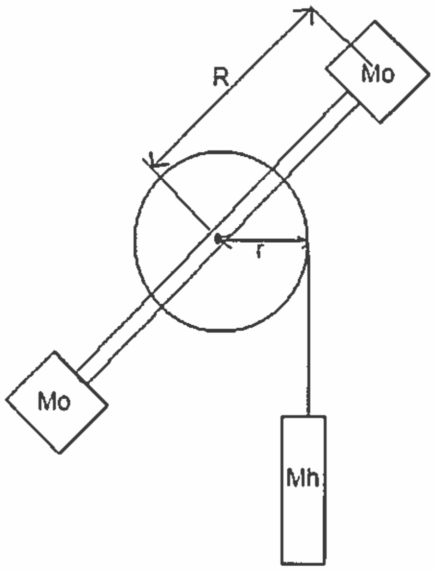
Investigating the Moment of Inertia of a Rotational System Theory: The rotational version of Newton's second law says that the net torque $\Sigma\tau$ applied to a system is directly proportional to the angular acceleration α of the system about the rotation axis. The proportionality constant is called the moment of inertia, and has symbol I.

$$\Sigma\tau = I\,\alpha.$$

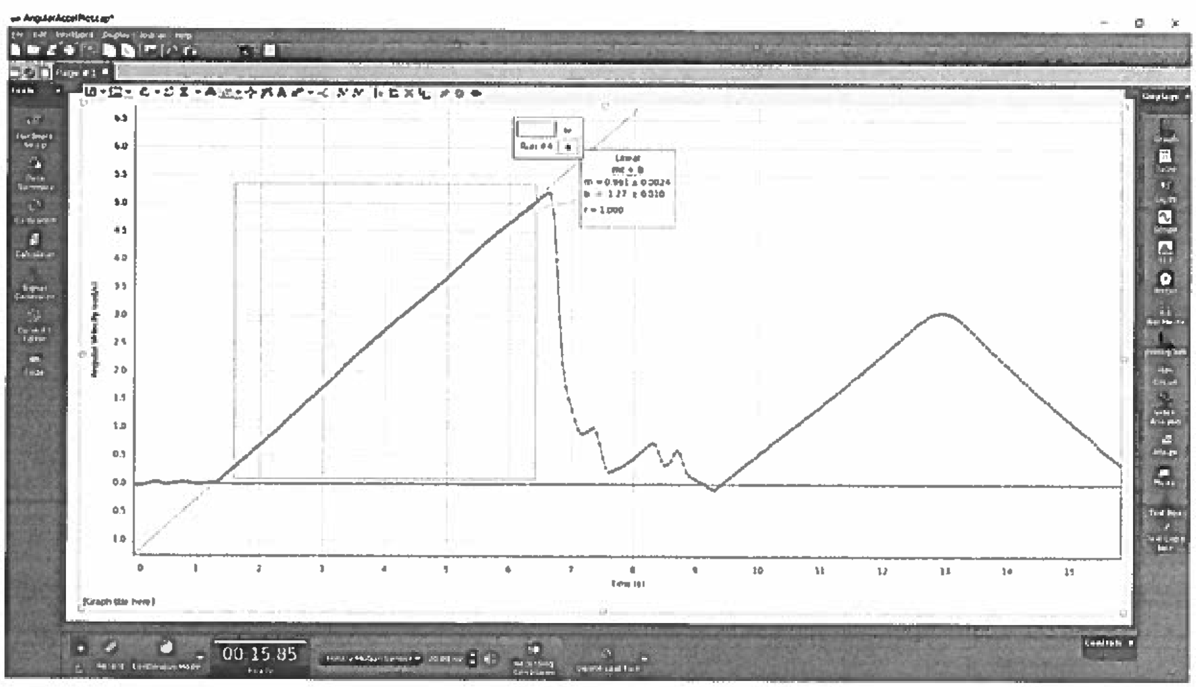


<u>**Testing the hypothesis**</u>: We'll test this law using data taken with a system consisting of a rotating rod attached to a hanging mass with a pulley. The diagram shows that there are two orbiting masses Mo that can be placed at various distances R from the center of rotation and that there is a hanging mass Mh attached to a pulley with radius r. This distance r is the lever arm used to calculate the torque applied to the rotating apparatus by the tension T in the string. In this lab we will find the Moment of inertia, I, experimentally by linearizing $\Sigma\tau = I\,\alpha$ and graphing the results. We will then find the moment of inertia, I, theoretically by using the general moment of inertia equation: $I = mR^2$

in combination with the specific moment of inertia equation for a rotating rod: $Irod = \frac{1}{12}ml^2$

*****All data taken in this experiment should have <u>*3 significant figures*</u> at least**

How to acquire α . Use the Capstone set up file from the lab calendar. This will give a graph of the angular speed (ω) vs time. Since $\alpha = \frac{\Delta\omega}{t}$, the slope of the capstone graph will give the angular acceleration. The slope could be positive or negative depending on which way the string is wrapped On the pulley. Always record a positive α. Your instructor will demonstrate how to use the slope tool on Capstone.



Experiment 1. The rod alone:

Taking both orbiting masses off and placing them on the lab table, find the angular acceleration of the rod alone with hanging masses of 5g, 10g, 15g, 20g, 25g, and 30g.

Make a graph of τ vs α and determine the experimental moment of inertia of the rod alone.

Experiment 2. The rod and the orbiting masses about 20 cm apart:

Place the orbiting masses on the rod so the distance between their center of masses is about 20 cm. The mases must be balanced on the rod so that neither mass rotates to the lower part of the orbit when left to move freely. Once they are balanced, carefully measure this distance to the nearest mm. To measure the distance between the centers of mass measure the equal distance from the outside of one orbiter to the inside of the other. Find the angular acceleration of the rod with 2 middle distance orbiting masses with hanging masses of 25g, 30g, 35g, 40g, 45g, and 50g.

Make a graph of τ vs α and determine the experimental moment of inertia of the rod with 2 masses in the middle.

Experiment 3. The orbiting masses at the ends:

Balance the orbiting masses so they are near the end of the metal rod. Carefully measure the distance between their center of mass to the nearest mm. Find the angular acceleration of the rod with 2 orbiting masses at the end using hanging masses of 25g, 30g, 35g, 40g, 45g, and 50g.

Make a graph of τ vs α and determine the experimental moment of inertia of with 2 orbiting masses at the end.