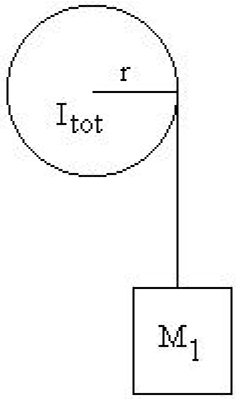
Name: ____________________

Torque and Moment of Inertia Alpha Bravo Charlie



Refer to the diagram to the left. There is a pulley of radius r and moment of inertia I_{tot} with a mass hanging off of it. Using Newton's 2^{nd} law and the fact that torque is equal to $I_{tot}\alpha$, we can show that

$$m_1 g = a_t (m_1 + \frac{\sum I}{r_{pulley}^2})$$

When doing the lab:

1. Make sure you wind the string about the bottom (or largest pulley)
2. Before you release the system from rest, make sure that the hanging mass is not swinging
3. All measurements and calculations will be bolded
4. Check with instructor at the end of each situation for a check

Hanging mass: ________________________

Radius of bottom pulley: 0.0238 m

Situation #1: The "Empty" System

Set up your equipment such that it looks similar to photo to the left.

Instructions:

1. Load mominert1.ds
2. Wind the string about the bottom pulley
3. Run the program and release the system from rest
4. Extract the tangential acceleration from the graph by finding the slope of the line (Use linear fit function)
5. Calculate the tangential acceleration using the formula

$$m_1 g = a_t (m_1 + \frac{I_{empty}}{r_{pulley}^2})$$

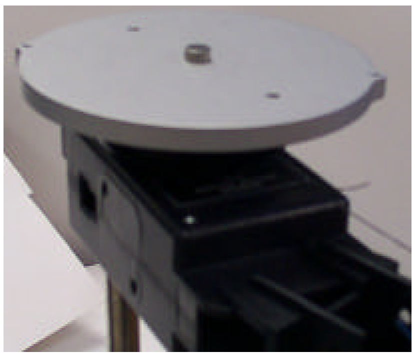
$\mathbf{I}_{empty} = 3.86*10^{-6}$ kg m^2

a_t from the computer: ________________________

Calculation of a_t

Percent Error (the computer a_t = the theoretical value): ______________________

Situation #2: Empty System + Disk



Set up your equipment such that it looks similar to the photo to the left.

Instructions:

1. Load mominert2.ds
2. Wind the string about the bottom pulley
3. Run the program and release the system from rest
4. Extract the tangential acceleration from the graph by finding the slope of the line (Use linear fit function)
5. Calculate the moment of inertia of the disk using the formula

$$m_1 g = a_t (m_1 + \frac{I_{disk} + I_{empty}}{r_{pulley}^2})$$

6. Calculate the moment of inertia of the disk using the formula $I_{disk} = \frac{1}{2} m_{disk} r_{disk}^2$

a_t from the computer: ______________________

Mass of disk: ______________________ Radius of Disk: ______________________

Calculation of the moment of inertia from steps #5 and #6

Percent Error (assume $I_{disk} = \frac{1}{2} m r^2$ = theoretical value): ______________

Situation #3: Empty System + Disk + Rod

Set up your equipment such that it looks similar to the photo to the left.

Instructions:

1. Load mominert3.ds
2. Wind the string about the bottom pulley
3. Run the program and release the system from rest
4. Extract the tangential acceleration from the graph by finding the slope of the line (Use linear fit function)
5. Calculate the moment of inertia of the rod using the formula

$$m_1 g = a_t (m_1 + \frac{I_{rod} + I_{disk} + I_{empty}}{r_{pulley}^2})$$

6. Calculate the moment of inertia of the rod using the formula $I_{rod} = 1/12\ M\ L^2$

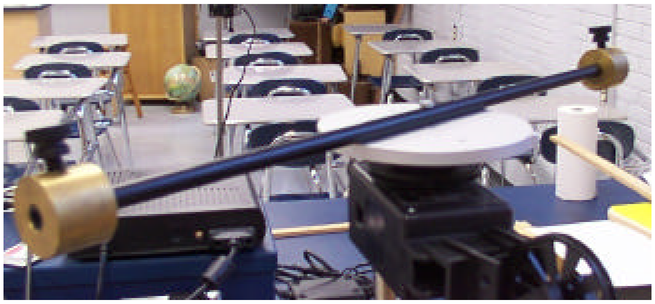
a_t from the computer: ______________________

Mass of rod: ______________________ **Length of rod: ______________________**

Calculation of moment of inertia from steps #5 and #6

Percent Error (assume $I_{rod} = 1/12\ M\ L^2$ = theoretical value): _____________

Situation #4: Empty System + Disk + Rod + Masses



Set up your equipment such that it looks similar to the photo to the left. The two end masses should be at the end of the rod.

Instructions:

1. Load mominert4.ds
2. Wind the string about the bottom pulley
3. Run the program and release the system from rest
4. Extract the tangential acceleration from the graph by finding the slope of the line (Use the linear fit function)
5. Calculate the moment of inertia of the two masses using the formula

$$m_1 g = a_t (m_1 + \frac{I_{mass} + I_{rod} + I_{disk} + I_{empty}}{r_{pulley}^2})$$

6. Calculate the moment of inertia of the two masses using the formula I = Ó (mr^2)

a_t from computer: ________________

Mass of end mass$_1$: ____________ Mass of end mass$_2$: __________

Distance masses are from the axis of rotation: ____________ & ____________

Calculation of moment of inertia from steps #5 and #6

Percent Error (assume I = Ó (mr^2) **= theoretical value): ______________**

Questions:

If a given system is made of many objects, the moment of inertia of that entire system is:

a) the sum of all of the moment of inertias of the individual objects
b) the product of all the moment of inertias of the individual objects
c) cannot be determined

In the lab, as the total moment of inertia increased, the angular acceleration

a) decreased
b) increased
c) remained the same
d) cannot be determined

Why is it easier to balance a hammer with the head part up?

Why does holding a long pole help a tightrope walker stay balanced?

Using the information given in the first paragraph of the lab, along with the diagram next to the paragraph, derive the following equation:

$$m_1 g = a_t \left(m_1 + \frac{\sum I}{r_{pulley}^2}\right)$$