Modified Atwood Machine Lab 4 Name: ___________________

Objective:

To verify the equations relating to constant acceleration, friction, and Newton's second law of motion as applied to Atwood's Machine.

Materials:

Two pulleys, two strings, two cups, 4 paperclips, masses, meter stick, stopwatch, gray track, wood block, force sensor, lab quest

Introduction:

Part A

Find the coefficient of kinetic friction for the gray track and the block of wood. Measure the mass of the wood block using the digital scale. Place additional mass on top of the wood block. Connect the force sensor hook to the wood block with additional mass and pull with a constant velocity on the gray track. Be certain that when you pull the block with the force sensor you are pulling parallel with the ground. You should not add any upward or downward force on the block as it is being pulled. Record the total mass and the force required to move at a constant velocity (aka Kinetic Friction) in the table below. Add additional mass and repeat three times, adding more mass each time. Calculate the normal force on the block and the coefficient of kinetic friction (aka Mu) for the block and track. Divide kinetic friction by the force normal to calculate Mu. Find the average Mu.

	kg	m/s	Newtons	Newtons	
Scenario	Total Mass	Velcoity (m/s	Force Normal	Kinetic Friction	Mu
1					
2					
3					
4					
				Average Mu:	

Part B

This modified Atwood machine will consist of two hanging masses (i.e. cups) each suspended by a pulley and both connected with string to a central mass (i.e. wood block) that has friction. When the cup masses are sufficiently unequal, the system will accelerate in the direction of the heavier cup. In this experiment, you will measure the acceleration and compare it to that predicted by Newton's second law. For the purposes of this experiment, we shall assume that the acceleration is constant. Therefore, if the system begins at rest, y is the distance traveled and t is the time it takes to go a distance of y. You will measure y and t to calculate the acceleration, using the kinematic equation:

$$y = \frac{1}{2}at^2$$

1. Connect the wood block to the two cups via two lengths of string over two pulleys on opposite sides of the gray track. The string lengths should be such that when one cup is near table or counter height, the other is on the ground. Measure the height of the table or counter cup: y=___ m
2. Place an unequal amount of mass in both cups such that the system easily accelerates.
3. Pull the light side down to the floor and hold it. Place something soft to gently break the fall of the heavier cup as it accelerates to the floor.
4. Begin at rest and time the fall of the heavy cup by starting the stopwatch as you release the cup and stopping it when it reaches the floor. Take three time readings and record them in a data table. Find the average.
5. Add an additional mass on top of the wood block. Repeat the previous steps 3 times, each time adding an additional mass to the wood block.
6. Fill in the table with your data. Calculate the acceleration of the system using kinematics.

					Heavier	Lighter			
Scenario	Time 1	Time 2	Time 3	Average Time	Cup 1	Cup 2	Block	Total Mass	Acceleration
1									
2									
3									
4									

Part C

Using a Newton's 2nd Law literal equation, applied to the modified atwood machine, calculate the acceleration of the system, in each of the four scenarios. Include friction. Show your work below.

Scenario 1 Scenario 2 Scenario 3 Scenario 4

Acceleration with Newton's 2^{nd} Law:

	Heavier	Lighter			mu*m*g		
Scenario	Cup 1	Cup 2	Block	Total Mass	Kinetic Friction	Net Force	Acceleration
1							
2							
3							
4							

Find the percent difference in the kinematics acceleration (experimental) and the Newton's 2^{nd} Law acceleration (actual) for all three scenarios.

$$\%error = \left(\frac{Actual - Experimental}{Actual} \right) x100\%$$

Scenario 1: _______%   Scenario 2: _______%   Scenario 3: _______%   Scenario 4: _______%

Why are there discrepancies between the actual and the experimental accelerations? Describe at least two potential sources of error. Answer with complete sentences.

What happened to the acceleration as mass was added? Did net force change? Explain.