

Objective:

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

Materials:

pulley, pulley stand, string, two cups, 3 paperclips, masses, meter stick, stopwatch

Procedures:

The Atwood's Machine is simply a pulley of negligible inertia and friction over which are suspended two masses. When the masses are unequal, the system will accelerate in the direction of the heavier mass. 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. Use a length of string such that when one cup is at the table or counter height, the other is on the ground when the string is laced through the pulley. Measure the height of the table or counter:
 $y = \text{_____ m}$
2. Place an equal amount of mass (around 300g) in both cups. No motion should occur.
3. While holding the system at rest (gently place your finger under the cup), add a small mass (e.g. 10 grams) from the low cup to the higher cup, then let go to see if the system moves. If not, see if it will move after a slight push. If it still doesn't move, try transferring another small mass; continue transferring mass until the mass moves.
4. 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.
5. Begin at rest and time the fall by starting the stopwatch as you release the heavier mass from the table, and stopping it when it reaches the floor. Take three time readings and record them in a data table. Find the average.
6. Add an additional small mass to the heavier cup. Repeat the previous steps for scenario 2.
7. Add an additional small mass to the heavier cup. Repeat the previous steps for scenario 3.
8. Fill in the table with your data. Calculate the acceleration using kinematics.

Acceleration with Kinematics:

					Heavier	Lighter		
Scenario	Time 1	Time 2	Time 3	Average Time	Mass 1	Mass 2	Total Mass	Acceleration
1								
2								
3								

9. Using a Newton's 2nd Law literal equation, applied to the Atwood machine, calculate the acceleration of the system, in each of the three trials. Show your work below.

Scenario 1

Scenario 2

Scenario 3

Acceleration with Newton's 2nd Law:

	Heavier	Lighter			
Scenario	Mass 1	Mass 2	Total Mass	Net Force	Acceleration
1					
2					
3					

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

$$\%error = \left(\frac{Actual - Experimental}{Actual} \right) \times 100\%$$

Scenario 1: _____%

Scenario 2: _____%

Scenario 3: _____%