Name: ______________________________

LAB 6. ATWOOD'S MACHINE

Introduction

This lab's system is a classic Atwood machine with two masses connected by a string over two pulleys. The heavy mass falls, lifting the light mass until the heavy mass lands on the floor. You will measure the acceleration of the masses as they move.

Purpose

Your goal is to understand how the acceleration depends on the particulars of the system. You are to derive from physical principles a theoretical formula that predicts the acceleration of the weights from the characteristics of the system, and experimentally check how well that formula reproduces the actual behavior of the system.

Supplies

Board with one standard pulley and one smart pulley, two mass hangers with masses, fishing line, Capstone data setup, pads for the floor

Data Collection

When the falling mass hits the ground, the rising mass may continue moving upward. It is best if a student is ready to catch the rising masses after the falling mass lands on the pad.

1. Place pads under both pulleys. There should be more padding under the heavier weight.
2. Run the string over the two pulleys. Hang the hooks of the mass hangers through the loops at each end of the string.
3. Lower the lighter mass so that it is near the floor.
4. Start data collection.
5. Release the masses so that the lighter mass is pulled upward by the falling heavier mass. Catch the rising lighter mass after the falling mass hits the floor.
6. Stop data collection.
7. Make a velocity-time graph of the run. Fit the linear (constant-acceleration) portion of the graph to a linear fit. The slope of this line is the acceleration of the hanging weight. Record the masses and this acceleration in your lab book.
8. Repeat several times to characterize the variability of your measured acceleration.
9. Repeat steps 3-8 with different hanging masses according to your experimental design.

Data Processing

1. Find the formula for the expected acceleration a of the masses in a frictionless Atwood machine. Record its derivation in your lab book. Present it to your instructor for verification.
2. Enter your data into a spreadsheet. Use a separate row for each run.
3. In a new spreadsheet column, use your model to calculate the expected acceleration a of the masses.

4. How can you determine whether the accelerations predicted by your model adequately match the measured values? What would constitute an adequate fit? What observations might suggest that your model is missing something, or getting something wrong? Ponder these questions, discuss them with your lab partners, and ask your instructor questions.
5. Display or otherwise test your model against the data to answer these questions. Are there more experimental data you don't have that would help you to further investigate these questions?

Lab Report

Present your findings in a brief, lucid report. It should contain the following parts.

Abstract

Briefly explain the system you studied, the measurements you took, and the quantities you calculated from the measurements.

Purpose

What principles of mechanics does the Atwood machine help us to understand? What about the system and model do I want you to test? How does the experiment you ran illuminate the physics of the system?

Theory

Report the formula you derived to model the acceleration of the masses in the Atwood machine. Also explain how factors not accounted for by the model might make the actual behavior of the machine differ from the model's predictions.

Experimental

Describe the setup of your apparatus. Explain how you made measurements and found the accelerations of the hanging masses. Report any concerns with safety or damage to the equipment, and steps you took to ensure proper operation.

Observations and Data

Share your spreadsheet, containing the well-labeled data, with your instructor.

Analysis and Discussion

Identify possible sources of error in your measurements, and estimate the likely magnitude and significance of the errors. Explain how you examined your experimental data to check if the model adequately predicts the behavior of the system. Tell what you found, and the degree to which you are confident in your findings.

Conclusion

Is the model you derived an adequate model of the Atwood machine? Is there any evidence that influences not accounted for in the model, such as friction, drag, or inertia of the pulleys, can or can not safely be neglected? Defend your conclusion.