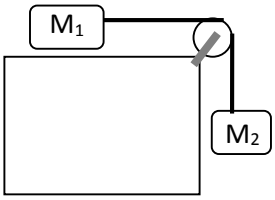
Possible Pre Lab 4 questions
Read Lab 4

Answer the following questions

1) An object of mass, m_1, is placed on a rough table and connected to a string which passes under a pulley then over a pulley and then is fastened to a hanging mass, m_2. Assuming m_1 is stationary, how would you measure the coefficient of friction on m_1? (That is calculate a formula for μ_s as a function of m_1 and m_2)



2) If the mass of $\mathbf{m_2}$ is increased until $\mathbf{m_1}$ accelerates with acceleration **a**. What is the coefficient of friction, $\boldsymbol{\mu_k}$ in terms of m_1, m_2, a and g? (Here are a list of hints to help guide you through the problem.)
    a. Create free body diagrams for m_1 and m_2. Make sure you note that the tension forces on the two objects is the same magnitude. Also remember that the accelerations of the two objects are the same magnitude.
    b. Create a formula for the Normal force on m_1. From this calculate the Frictional force on m_1.
    c. Use Newton's second law in the x direction for m_1, AND use Newton's Second Law in the y direction for m_2. Solve for the coefficient of friction μ_k.

Lab 4

Friction OR "What do I do with all this data?"

In this lab we will experimentally explore the relationship between the normal force on an object, the friction that object feels, and the tension force on that object. Each group should gather the following equipment:

1 computer (turn this on immediately as it takes a long time to load. Also, start the "Logger Pro" software as soon as possible.)
1 LabQuest
1 PhotoGate which needs
    1 cable for connection with the LabQuest
    1 stand so the photogate can measure the motion of the pulley wheel.
1 "Superpulley"
1 clamp which attaches to the track and the pulley.

1 "Pasco" track -- **leveled to the best of your ability**. You might want to use the bubble level.
1 wooden block with a hook.
1 string approximately 80 to 100 cm long
1 or 2 boxes of mass to hang from the string.
1 Caliper
1 triple beam balance
1 "Tare" – a weight designed for the balance to increase its measurement range.

A 10% penalty will be assessed to any group who does not return all supplies neatly at the end of the lab period.

Task 1-Measuring the static coefficient of friction.

Procedure

1) Place the Pasco Track such that one end is hanging off the end of the table.

2) On this dangling side of the track attach the clamp with the pulley.

3) Adjust the Photogate so that the laser passes through the pulley's spokes.

4) Place the wooden block on the track with the hook toward the pulley.

5) Tie one end of the string to the hook and place the middle of the string in the groove of the pulley.

6) Hang mass from the free end of the string.

7) Carefully determine how the maximum value of m_2 such that m_1 will not move. Estimate an uncertainty in this value?

8) Place a large amount of mass (at least 50% of the mass of the block) on top of the wooden block and repeat 7 and 8.

Analysis

Determine coefficient of static friction with uncertainty using your answer to "Possible Prelab question 1" for each trial.

The Researcher should explain how the equation for the static coeffiecent of friction is a result of Newton's second Law. (Basically show the work of how the group arrived at the formula you used to calculate the coefficient of static friction.)

The Data Analyst should create a bar chart to compare the two coefficients. As well as label all units, etc..

The PI should address in the conclusion how the bar chart answers the question: "Does the static coefficient of friction depend on the mass of the wooden block?"

Task 2- Measuring the kinetic coefficient of friction.

We will use the experimental setup of Task 1 to test our results of theory question 2.

Procedure

1) Wrap the string completely around the pulley. Use this to directly measure the circumference of the pulley wheel inside its groove.
2) Count the number of spokes in your pulley. Use this information to figure out how far the block will move if the pulley rotates from one spoke to the next. **(Important note, we will be using the Spoke to Spoke distance NOT the Spoke to Gap distance. Because the Photogate records times in a (spoke, gap, spoke, gap, spoke, gap…) fashion we will "skip a time" when calculating Δt in the denominator of our velocity formula!**

3) Hang mass from the free end of the string so that the block accelerates toward the pulley. **CATCH the block before it crashes.**

4) Take data as the block slides along the track. I would like for you to have 2 runs. That is two different m_1's and m_2's.
   i) One where the block accelerates toward the pulley.
   ii) A second case where the block accelerates toward the pulley, but with additional mass on the block.

Analysis

For each trial I am assuming you have at least 50 different times coming out of Logger Pro as the pulley spins. Rather than working with the data line by line, I would like for you to copy the data into Excel and use the data processing abilities of a spreadsheet to process your data.

Using your fledgling programing skills in Excel use your list of 50 different times to create a list of 50 different velocities. Create a scatter plot for each trial of "Velocity vs Time" with around fifty points. (Each trial should get its own plot).

From this scatter plot, you will ask Excel to create a linear trendline, complete with equation. From the equation of the trend line, you should be able to easily evaluate the acceleration(s) and put it (them) in the peach acceleration box. Finally use "Possible Prelab Question 2" to calculate the coefficient of kinetic friction from the data you have found. **Watch out for the unit mismatch between your acceleration and the acceleration of gravity.**

The Researcher should explain how the equation for the **Kinetic coefficient of friction** is a result of Newton's second Law. (Basically show the work of how the group arrived at the formula you used to calculate the coefficient of static friction.)

The Data Analyst should create a bar chart to compare the two coefficients. As well as label all units, etc..

The PI should address in the conclusion how the bar chart answers the question: “Does the **kinetic** coefficient of friction depend on the mass of the wooden block?”