LAB 5. FRICTION

Investigation

In this lab you will test the supposition that the force of friction between two objects follows the form $f = \mu N$, where N is the normal force between them and μ is a constant depending only on the materials.

Possible Questions

- Does the force of kinetic friction depend on the relative speed of the contacting objects?
- Does the force of kinetic friction depend on the magnitude of the normal force?
- Does the force of kinetic friction depend on the area of contact between the surfaces?
- Does the force of kinetic friction change over time?
- How does the incline of a surface affect the force of friction?

Tasks

- Measure the acceleration of an object acted upon by a force of friction.
- Determine all other forces acting on the object.
- Determine the normal force between contacting surfaces.
- Vary the variable that you are testing for influence on the system. Take enough measurements at each value to have faith in your numbers and to be confident that you understand their variability.

Measurements

Acceleration

You have used the PASCO motion sensors in two labs already, so you know that instantaneous acceleration measurements are reliable only for the most precise data sets. However, one can obtain reliable average accelerations over substantial time intervals from the velocity-time plot.

1. Record the motion data in Capstone. Create a velocity-time plot.
2. Select a linear region of the velocity-time plot. Fit a linear trend line to the data.
3. The slope of the trend line is the average acceleration in that region.

Motion sensor

You should already know how to set up and use the PASCO motion sensor. Use it to track the motion of a sliding object.

Smart pulley

A smart pulley is an excellent tool to follow the change in position of an object pulled by a cord that can be passed over a pulley. Measuring the rotation of the pulley accurately tracks the position of the tethered object, without the frustrating excursions often seen in measurements with the sonar motion sensor. It consists of an electric eye on a pulley with spokes. When the pulley rotates, the spokes interrupt the beam of the electric eye, signaling motion. Instead of sampling a certain number of times per second as the motion sensor does, the smart pulley signals every time a certain rotation is completed. It detects at a constant distance interval, rather than at a constant time interval.

Processing, Analysis, and Interpretation

If you took multiple measurements of a particular outcome, how can you characterize its most likely value (the "estimate") and its variability? How can you find the parameters to use in the equations of motion that make up your model of the system? What parameters did you use, and why? How would errors in the parameters effect your model's predictions?

You can measure lengths and masses. You can find velocities and average accelerations using the PASCO apparatus and Capstone software. How can you find friction? How can you determine if it follows or departs from our model?

Lab Report

There will be one report per lab group.

Abstract

Briefly describe the apparatus, measurements, and what you did with the measurements.

Purpose

Why am I making you do this? What is its educational value?

Theory

What is the standard model of friction? What is our model of the net force in the situations you studied? How does the model predict that acceleration will respond to your experimental conditions?

Experimental

Explain the setup you used and the measurements you took to determine the force of friction under different circumstances. Explain steps you took to minimize experimental and measurement error.

Observations and Data

Your primary data should be recorded in your lab notebook. In your report, present the data in a form that is easy to visualize and understand.

Analysis and Discussion

Compare your experimental findings to the predictions of the $f = \mu N$ model. Do your experiments show that the model accurately predicts the data? If so, what coefficients μ did you find for the surfaces you investigated?

Identify known or suspected errors in your measurements. Explain how these errors would affect your measured values.

Conclusion

Do your experiments suggest that our standard model of friction adequately predicts actual results, or do they call it into question? If the model of friction fails, in what way does the force of friction depart from the model?