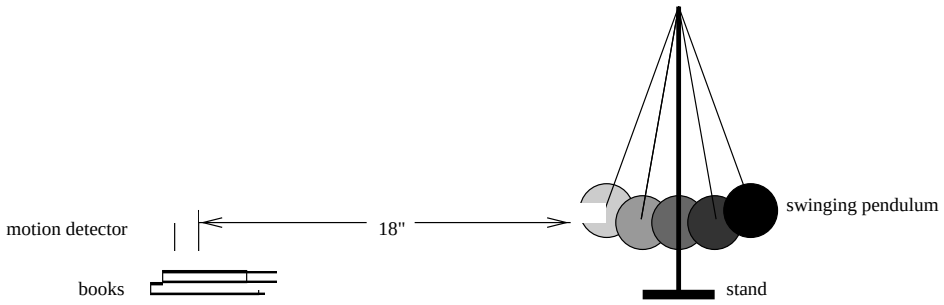
FUNCTIONS EXPERIMENT
PENDULUM

Introduction

For a pendulum swinging back and forth, the amount of time required to complete one full swing is called the period. Galileo discovered that the period depends only on the length of the pendulum and the acceleration due to gravity. In fact, the period and the length of the pendulum are related by a power function. In this lab we will establish the relationship between the period and the length of the pendulum by measuring the period for differing lengths.

Equipment and Setup

For this experiment you will need a TI calculator with the Vernier PHYSICS program loaded, a CBL unit, a motion detector, and a pendulum.



Set up the pendulum as shown above. Place the motion detector facing the path of the swinging pendulum. The detector will not measure objects within 18 inches, so be sure to set it at least 18 inches from the widest point of the arc. You may need to set the motion detector on a stack of books to get the pendulum directly in the path of the detector. To set up the CBL unit to record measurements, first plug the motion detector into SONIC on the CBL unit and turn the CBL unit on. Select the PHYSICS program on the calculator. In the home menu choose SET UP PROBES. When asked for the number of probes, enter 1. In the next menu choose MOTION. The screen will display the home menu again. Now select COLLECT DATA, and choose TIME GRAPH. Set the calculator to take 150 measurements 0.05 second apart. The calculator will then ask if you want to change the setup or continue. The next screen will notify you that the calculator is ready to begin taking measurements.

Procedure

When the calculator is ready to begin taking measurements, gently swing the pendulum in the direction of the motion detector. Note that the pendulum will swing out of the vertical range of the motion detector if the pendulum swings too high. Press ENTER on the calculator to begin taking measurements. The calculator will then display the graph of the distance of the pendulum from the motion detector versus time. Depending on the length of the pendulum, you should see between three and five periods. Repeat the procedure until you get a satisfactory graph.

Data

To determine the period of the pendulum, you will divide the length of time it took to cover the complete periods (as shown in the graph) by the number of periods shown.

Record the number of complete periods shown in your graph: _____

Record the time at the beginning of the first complete period: _____

Record the time at the end of the last complete period: _____

Now compute period of your pendulum.

Measure the length of your pendulum, from the top to the middle of the bob, and record the length in inches: _____

Record the length and period measurements from the other groups in your class in the table below.

Length (inches)				
Period (seconds)				
Length (inches)				
Period (seconds)				

Analysis

1. Enter the lengths in L1 and the periods in L2. Plot the data and sketch the plot below.

2. As stated in the introduction, the period is a power function of the length. That is, if P represents the period of the pendulum and L represents the length, we have the relation $P = cL^k$. Estimate the value of k by observing the graph, and explain why you chose this particular value.

3. Verify the claim that P is a power function of L by graphing $\ln P$ versus $\ln L$, and sketch that graph below. What characteristics of the graph support that claim?

4. Find a formula for the regression line of $\ln P$ against $\ln L$.

5. Use your answers to Part 4 to find a formula which models P as a power function of L.

Conclusions

In this part of the lab, you will need to construct a pendulum with a period of exactly two seconds. First you will need to determine the length of the pendulum, and then you will need to test your pendulum using the CBL equipment. While completing this task, your group should keep this question in mind: Does the angle of release affect the period of the pendulum? Your write-up for this portion of the lab should include a description of how you determined the required length of the pendulum, an account of the procedure used to test your pendulum, the results of the test, and any conclusions your group formed after performing the test.