

PENDULA

Introduction

Pendula are systems that bob back and forth at regular intervals. In this lab, you will study three different systems: simple pendulum, physical pendulum, and torsional pendulum (see pictures on next page).

Period is defined as the time for the pendulum to complete one full cycle of motion. The central question you will investigate is what variables affect the period. In the process, you will learn how to design a procedure to test a hypothesis, take precise time measurements, and use graphical analysis to determine the mathematical relationship between two variables.

NOTE: This lab assumes you know nothing about pendula. *If you've studied pendula before, do not assume you know the "answers" already!* The main point of this lab is to give you some experience with experimental design. Your conclusions for this lab should be based on observation- not on theory.

Instructions

For each pendulum:

1. Make the pendulum.
2. You may have heard a physics teacher claim that, for "small oscillations", the period of a pendulum does not change as the motion of the pendulum dies out. Take data to refute or support this claim for the pendulum you have made. Some issues to consider:
 - a. Is it better to measure the time it takes for a single swing or for multiple swings? Defend the reasoning behind your choice. (Notice that you cannot assume that each swing takes the same amount of time).
 - b. You will need to take multiple measurements to support/refute the claim. How much data is enough? Explain the reasoning behind your choice.

How "small" do the oscillations have to be? Do large oscillations have a shorter or longer period than smaller ones?

Study either the simple pendulum or the torsional pendulum in more depth:

1. Identify at least two parameters (e.g. the position of mass, length of string) you think could affect the period of your pendulum. Decide how you will measure each of these parameters. (e.g. If you measure the "length" of the something, where do you measure from?) Record these details in your notes. Diagrams may be more helpful than words.
2. For each parameter you identified in the previous paragraph, make a claim about whether that parameter affects the period of the pendulum. Take data that supports/refutes your claim. Explain how your data supports/refutes your claim.
3. Identify the parameter that affects the period of this pendulum the most.
4. Collect data to make a graph of your parameter versus period. Some suggestions:
 - a. Use as wide a range as possible for your parameter.
 - b. Do multiple trials.
 - c. Keep all other parameters as constant as possible.
5. Make the graph. Include bars which indicate the reliability of your data. Is your graph linear? a parabola? a square root curve? Use the shape of the graph to determine the mathematical relationship between the two variables. If you know how, "linearize" the data and interpret the slope. (Hint: To interpret the slope, look at the units on the slope of the linearized data).



Simple Pendulum



Physical Pendulum



Torsional Pendula