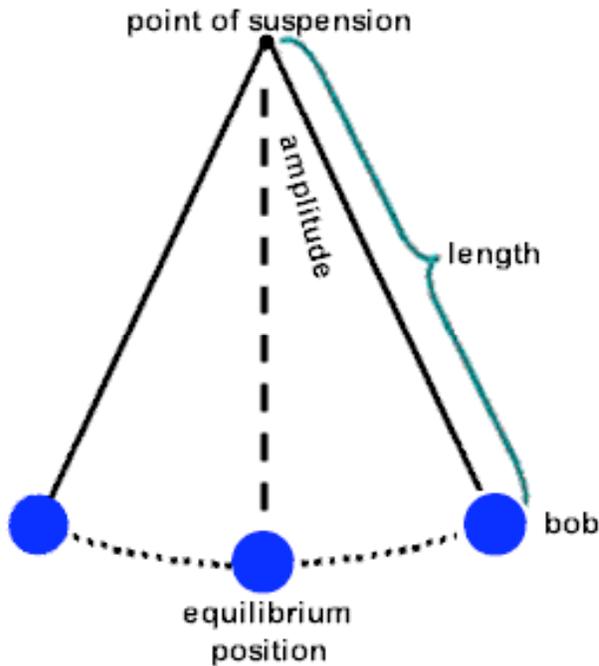


## Prelab: What Factors Affect the Period of a Simple Pendulum?

**Purpose:** To determine what factors affect the period of a pendulum and construct mathematical models for the relationship between these factors and the period. (you will rewrite this when you decide what factors you will be testing to make this statement more specific)

### Background:



A **simple pendulum** consists of a string, cord, or wire that allows a suspended mass to swing back and forth. The categorization of "simple" comes from the fact that all of the mass of the pendulum is concentrated in its "**bob**"—or suspended mass.

As seen in this diagram, the **length** of the pendulum is measured from the pendulum's point of suspension to the center of mass of its bob. Its **amplitude** is the string's angular displacement from its vertical or its equilibrium position. If a pendulum is pulled to the right side and released from rest, the time for one complete swing (the time for "bob" to return to its starting point) is called the **period** and is measured in seconds.

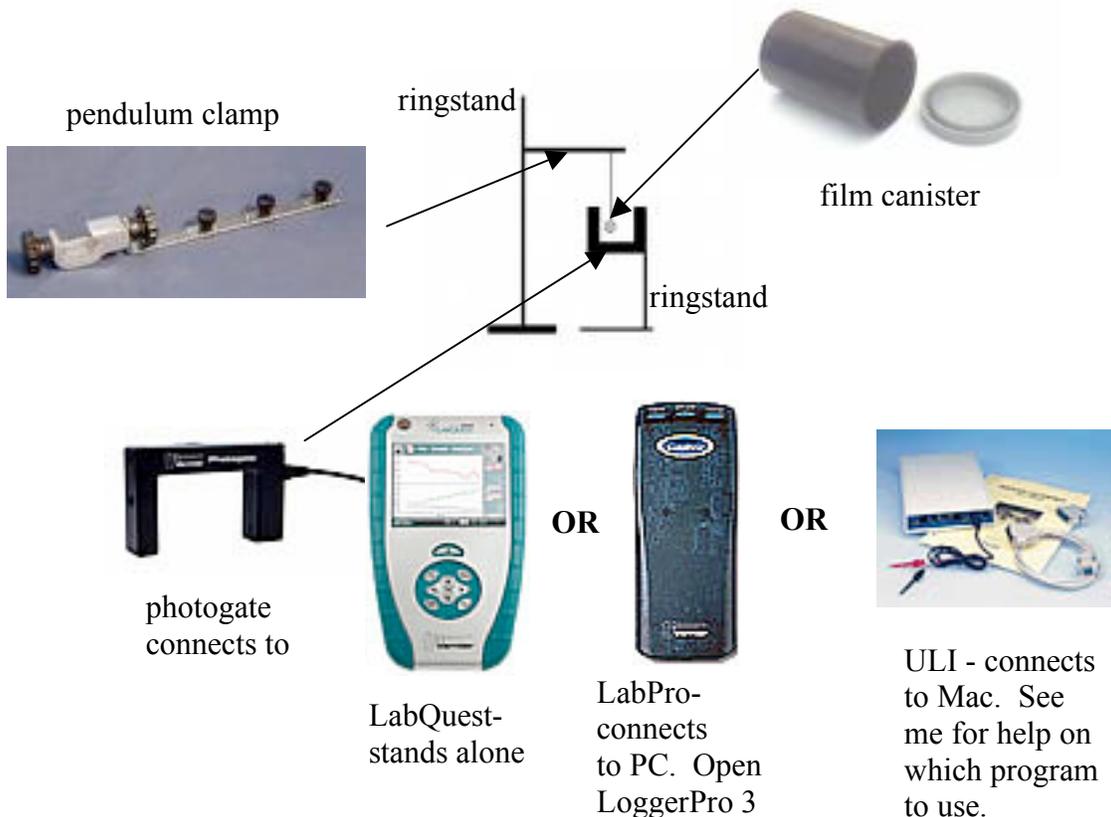
1. List all factors that you think could affect the period of a pendulum on a separate sheet of paper.
2. To determine a mathematical model for the relationship between each factor and the period, you will need at least 6 data points (and 3 trials per point). Which of the factors in your list can you measure and assign numerical values to? Go back to your list and cross off all factors that cannot be quantified.
3. Now that you have narrowed down your list, you need to make a separate hypothesis for the relationship between each factor and the period of a pendulum (be specific - choose from the five cases or graph shapes you've been studying). Set up your pendulum using a pendulum clamp and ringstand. For the pendulum "bob", we will be using a film canister filled with sand. Put a string through the cover of the film canister to complete the pendulum. Do some preliminary tests to see how each of your factors affect the pendulum's period. Record your observations and use them to explain the reasoning for each of your hypotheses.

4. Now you are ready to design your experiment. How will you test each factor or variable? What will you measure and how—what measuring devices do you need (protractor, electronic balance, ruler, etc.)? What are your independent and dependent variables? What will be your control variable in each case? Remember that for each factor or variable, you will need 6 different values and 3 trials per value.

*One of your data tables (you will have a different one for each factor or independent variable you are testing) might look like the one below. You will also need to write down the value of your controls (the factors you keep constant) for each experiment.*

length (cm)	period (s)			average
	trial #1	trial #2	trial #3	

*Suggestion for lab set-up. You will need to draw a labeled picture of your set-up for your lab report.*



## PENDULUM DATA COLLECTION

**NOTE: When testing amplitude, do not pull the pendulum back further than 30° from the equilibrium position. The mathematical model for large angles becomes more complicated than that of small angles.**

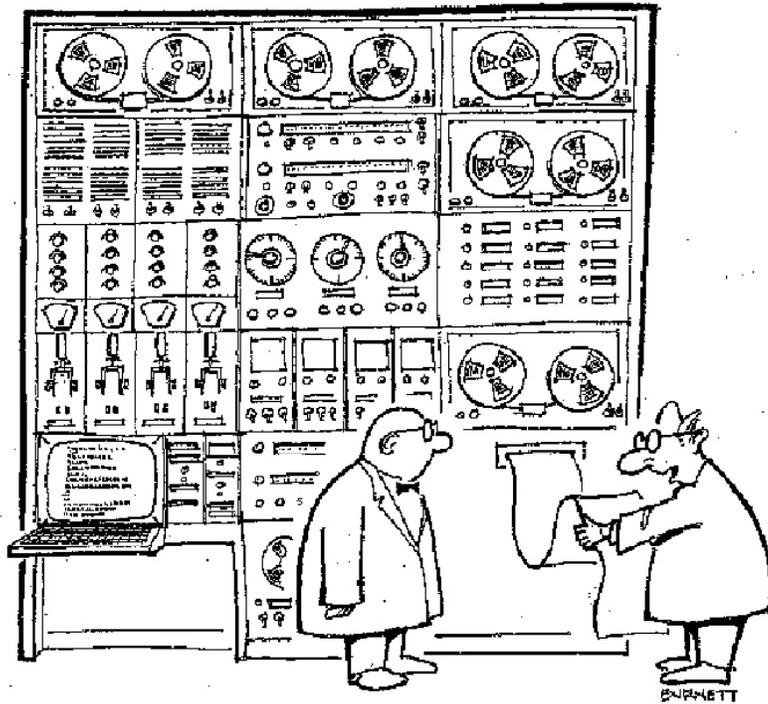
*Using LabQuest:*

1. Set-up your pendulum as shown on prelab.
2. Attach the Photogate to the second ring stand. Position it so that the mass blocks the Photogate while hanging straight down.
3. Connect the Photogate to DIG 1 of LabQuest and choose New from the File menu. If you have an older sensor that does not auto-ID, manually set up the sensor.
4. Set up LabQuest for data-collection with a pendulum.
  - a. On the Meter screen, tap Mode.
  - b. Change Photogate Mode to Pendulum Timing and select OK.
5. Temporarily hold the mass out of the center of the Photogate. If you have a Photogate with a tiny door on the inside, move it until it is shown as **Unblocked**. Observe the live readings on the screen. Block the Photogate with your hand. Note that the Photogate is shown as **Blocked** on the screen. Remove your hand and the display should change to **Unblocked**.
6. Temporarily hold the mass out of the center of the Photogate. Start data collection to prepare the Photogate.
7. Now you can perform a trial measurement of the period of your pendulum. Hold the mass from about 10° from vertical and release. (For a pendulum that is 100 cm long, that corresponds to pulling the bob only about 15 cm to the side.) After five periods have been recorded, stop data collection.
8. Choose Statistics from the Analyze menu. Record the Mean Period in your data table.
9. When you are ready measure another period, simply start data collection again. You will use this method for each period measurement.

*Using LabPro and Computer:*

1. Set-up your pendulum as shown on prelab.
2. Attach the Photogate to the second ring stand. Position it so that the mass blocks the Photogate while hanging straight down. Connect the Photogate to DIG/SONIC 1 on the interface.
3. Open LoggerPro and then the file “14 Pendulum Periods” in the *Physics with Vernier* folder. A graph of period vs. time is displayed.

4. If the collect button is not bright green with an arrow, LoggerPro does not recognize that your LabPro is connected to the computer. Go to **Experiment>Connect Interface>LabPro** and choose the correct port (COM1, COM2 or USB).
5. Temporarily move the mass out of the center of the Photogate. Notice the reading in the status bar of Logger *Pro* at the bottom of the screen, which shows when the Photogate is blocked. If you have a Photogate with a tiny door on the inside, move it until it is shown as **unblocked**. Block the Photogate with your hand; note that the Photogate is shown as **blocked**. Remove your hand, and the display should change to **unblocked**. Click  and move your hand through the Photogate repeatedly. After the first blocking, Logger *Pro* reports the time interval between every other block as the period. Verify that this is so.
6. Now you can perform a trial measurement of the period of your pendulum. Pull the mass to the side about  $10^\circ$  from vertical and release. Click  and measure the period for five complete swings. Click . Go to **Analyze>Statistics** or click the Statistics button, , to find the Mean Period. When you are ready measure another period, simply start data collection again. You will use this method for each period measurement.



*"It checks out OK on the computer, now let's confirm it with the pendulum."*