

## APPARATUS

- Computer and Pasco interface
- Heart rate sensor

## INTRODUCTION

This is a short experiment designed to introduce you to computer acquisition of data and the Pasco Science Workshop with its Capstone control program. It is not solely a physics experiment, but also an exercise to acquaint you with the equipment that will be used for “real” labs. If you are already familiar with computers, then this experiment will probably take less than an hour; if not, you should use any remaining time to practice with the computer.

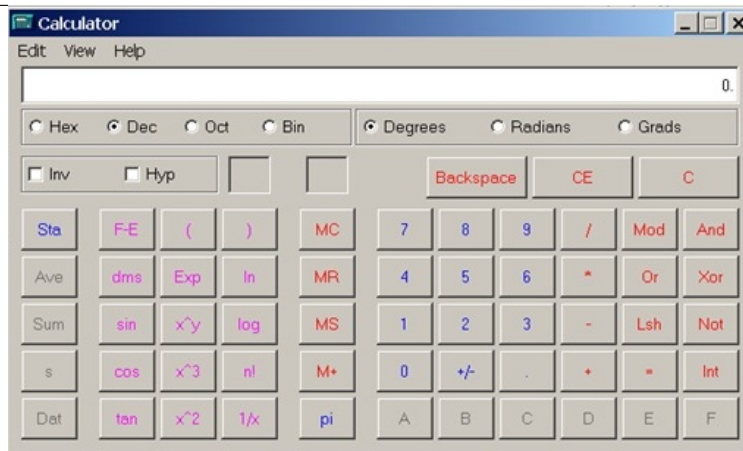
## COMPUTER EXPERIMENTS

Many experiments in the Physics 6A lab series utilize a desktop computer to acquire and analyze data. Most students entering UCLA are already familiar with the basic Windows operations of clicking and dragging with a mouse, pulling down menus, scrolling and resizing windows, and so forth. If you are not familiar with these operations, then consider this experiment a practice session.

It is likely that the computer has already been turned on when you enter the lab. If not, when you turn it on, it will take a minute or two for the system to “boot up”. In the entire Physics 6 lab series, two basic programs are used: Capstone (which controls an interface box to which various experimental sensors can be connected) and the spreadsheet program Microsoft Excel (which allows you to analyze and graph data). After the computer is booted up, you should see shortcut icons for these two programs on the desktop.

## SCIENTIFIC CALCULATOR

You may also have occasion to use an on-screen calculator while working on experiments. Bring up the calculator by clicking on the “Start” menu, go to “Programs”, then to “Accessories”, and finally to “Calculator”. When the calculator is displayed, pull down the “View” menu to “Scientific”, so that the type of calculator on the screen changes to scientific. If you have any difficulty bringing up the scientific calculator, ask your TA for assistance. You should be able to access the scientific calculator quickly at any time during the next three quarters of labs.



## THE PASCO INTERFACE

The Pasco Science Workshop system consists of an interface box controlled by the Capstone computer program, and a variety of different sensors that can measure distances and velocities by echo ranging (via a sonic ranger) or by motion of a smart pulley; as well as by voltage, heart rate, temperature, pressure, light intensity, magnetic fields, and many other physical quantities. Newer interfaces plug into a USB port of the computer, and have inputs for four digital channels and three analog channels. The interface can measure several quantities simultaneously and also has a built-in signal generator which can be controlled to produce 0 – 5 volt signals of DC, AC, and several other different wave forms. The software with the interface permits you to display and analyze the results in a number of different forms: digital meter, analog meter, graph, table, oscilloscope, and so forth.



## PROCEDURE

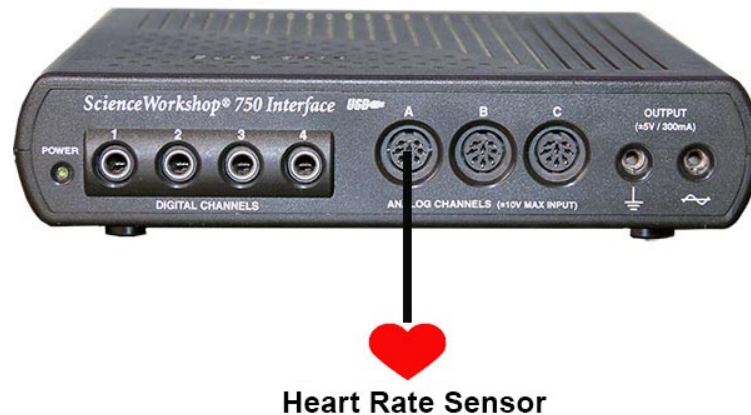
The terms in bold lettering below are basic computer operations with which you will need to be familiar by the end of this first experiment. If you have any difficulty with these operations, ask your TA; perhaps your lab partner can also help you. The partner less familiar with computers should perform most of the operations for this experiment. For the remaining experiments in the Physics 6 lab series, each partner should plan on performing half of the computer operations and half of the experimental setups and adjustments. Your TA has been instructed to intervene if he or she notices one partner doing a disproportionate share of either task.

The heart rate sensor consists of a small box with a multiple pin connector and a clip that attaches

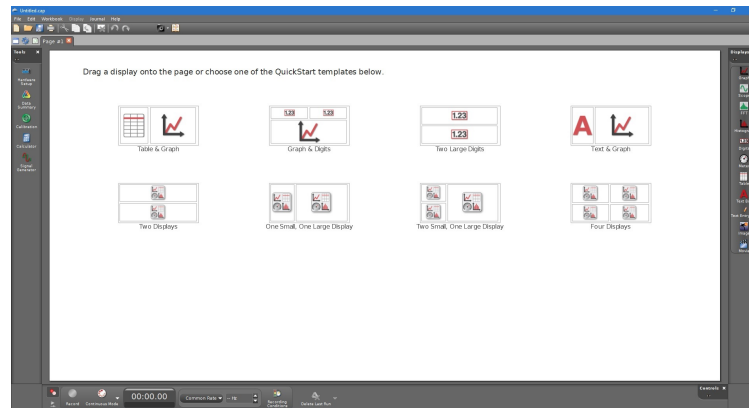
## Physics 6A Lab | Experiment 1

onto your ear lobe. The sensor measures the flow of blood through the lobe. As the heart forces blood through the vessels in the ear lobe, the light transmittance of the lobe is changed. The sensor monitors this light with a phototransistor.

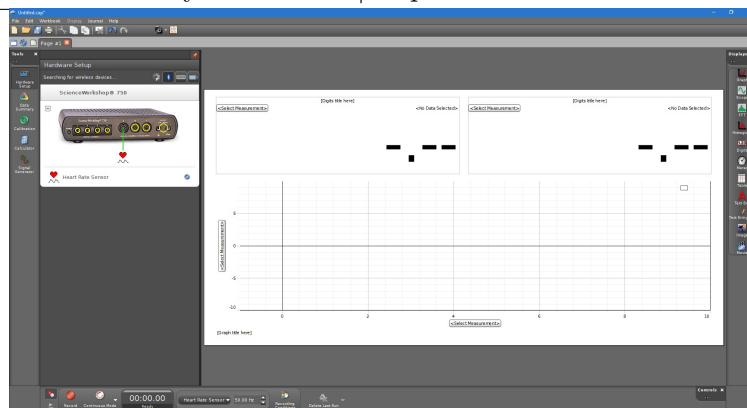
1. Plug the heart rate sensor into analog channel A, and turn on the signal interface.



2. On the computer screen, **double-click** on the PASCO Capstone icon to bring up the program. The illustration below shows the screen when Capstone is first loaded.



3. **Click** on the “Graph & Digits” option. Then **click** the “Hardware setup” button to display the interface. **Click** on Channel A of the interface and choose “Heart Rate Sensor”. Next, **click** the red thumbtack button above the interface to bring both windows into view. Your screen should look like the image below.



4. On the  $y$ -axis of the graph, **click** the “Select Measurement” button and select “Heart Rate (beats/min)”. Above the graph, **click** on the “Select Measurement” button in the digits box and choose “Heart Rate (beats/min)”.
5. You are now ready to check your heart rate. Clip the heart sensor to your ear lobe. (The newer sensor boxes also show your heart rate with an LED display on the sensor box.) **Click** “Record” on the bottom tool bar. Observe the data for about one minute, and then **click** “Stop”. You should see your resting heart rate (55 – 70 beats per minute for a typical person). The figure changes slightly every few seconds. If you do not see a clear, reasonable rate, try repositioning the ear clip or attaching it to your other ear. As a last resort, ask your TA for help.
6. To see the sensor voltage produced by your heartbeat, **click** on “Heart Rate” on the  $y$ -axis of the graph and select “Voltage (V)”. You will see the voltage output data of the heart rate meter as a series of pulses. If there are too many pulses that it looks messy, try zooming in by clicking and dragging on the numbers on the  $x$ -axis of the graph
7. Whenever you **click** “Record” in Capstone, your previous recordings are no longer displayed. However, if you wish to see them again, **click** on “Data Summary” to see all recordings. You can view them again by dragging them to the desired graph or table or you can drag them to the display icons on the right side of the screen.
8. When the graph and digits windows are positioned clearly on the screen, and you have some clear data for your heart rate and sensor voltage, ask your TA to check you off. Congratulations! You have now finished the first experiment.

## ADDITIONAL CREDIT: RAISING AND LOWERING YOUR HEART RATE (2 mills)

Throughout the lab sessions, you will have opportunities to earn “mills”, or tenths of a point, which are added to your final lab score. You can earn up to 20 mills, or two points. This additional credit assignment is worth two mills, but first, be sure you and your lab partner are both familiar with the Windows computer operations described above.

## Physics 6A Lab | Experiment 1

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The objective of this section is to raise your heart rate to a moderately high value by exercising, and then to produce a graph of heart rate as a function of time as the heart relaxes back to its resting mode. Before proceeding with the instructions below, be sure you have clicked “Stop” if the machine is still monitoring your heartbeat.

The sensor will not record an accurate heart rate when you are moving around. You will need to take off the sensor, exercise, and then hook yourself back up. Raise your heart rate to 140 beats per minute or higher by doing jumping jacks in position, or by going out and running around the building. Do not perform the exercise if you have a health problem. Have your lab partner or another volunteer do it. After exercising, reattach the sensor, and click “Record” to record your heart rate as a function of time. Remain as still as possible while the recording is made — say, for five minutes (or 300 seconds). Click “Stop” when you are finished.

Your graph should show a relatively smooth, decreasing heart rate from 140 beats per minute down toward your resting rate. If you do not obtain a smooth graph, get some more exercise and try again. Try to remain more still while recording, reposition the ear clip, or attach it to your other ear until you get a nice result. If the appearance of the graph is satisfactory, you can show this graph to your TA to collect two mills.