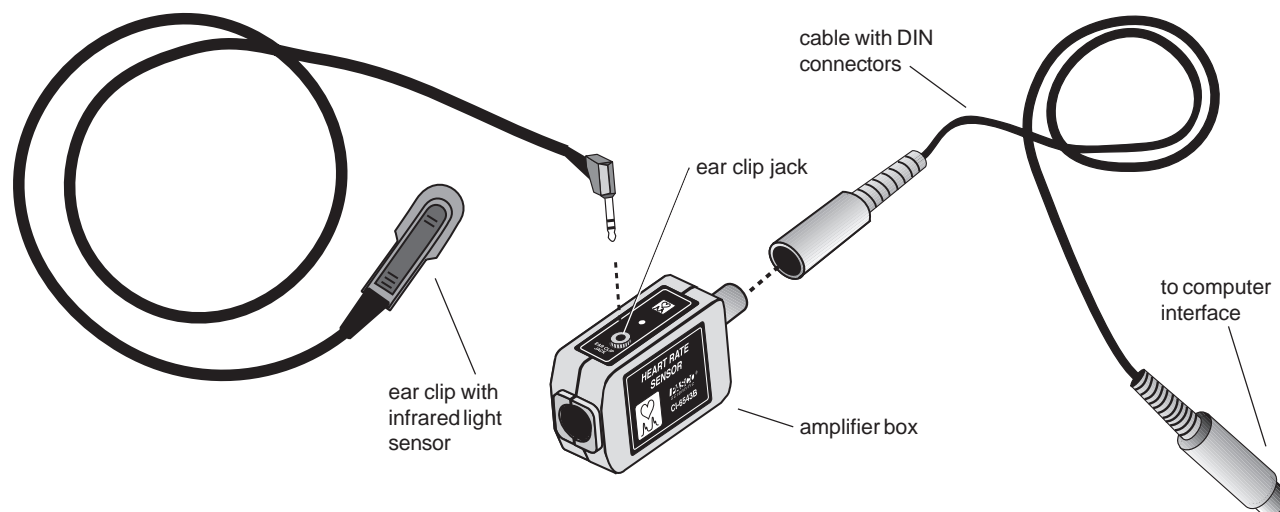


**Instruction Sheet
for the PASCO
Model CI-6543B**

HEART RATE SENSOR



Introduction

The PASCO CI-6543B Heart Rate Sensor works with a PASCO *Science Workshop*[®] computer interface to monitor a person's heart rate. Unlike an electrocardiograph (EKG), which monitors the electrical signal of the heart, the Heart Rate Sensor monitors the flow of blood through a part of the body, such as an ear lobe, by shining a light through it and monitoring the change in intensity. As the heart beats and forces blood through the blood vessels in the ear lobe, the light transmittance through the ear lobe changes.

The sensor consists of a Heart Rate Sensor amplifier box, a cable with DIN connectors for connecting to a PASCO computer interface, and an ear clip. The ear clip can be attached to a part of the body such as an earlobe, a fingertip, toe, or the web of skin between the thumb and index finger. The sensor shines an infrared light through the earlobe and measures the change in light that is transmitted. The light source is a small infrared light-emitting diode.

EQUIPMENT INCLUDED

- Heart Rate Sensor Amplifier Box
- cable with ear clip
- 6-foot cable with DIN connectors

ADDITIONAL EQUIPMENT REQUIRED

- computer (PC or Macintosh)
- *Science Workshop*[®] computer interface
- *Science Workshop*[®] software version 2.2. or higher

Note: This instruction sheet was written assuming that the user has a basic familiarity with *Science Workshop* and has access to the *User's Guide for Science Workshop*. Users can gain basic skills by working through the tutorial within *Science Workshop*. Another useful resource is the *Quick Reference Card for Science Workshop*.

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Operation

Setting up the Equipment

1. Connect the Heart Rate Sensor amplifier box to analog channel A, B, or C of the *Science Workshop* computer interface box using the cable with the DIN connectors (Figure 1). Alternatively, the amplifier box can be plugged directly into the analog channel jack.
2. Connect the ear clip to the ear clip jack on the Heart Rate Sensor amplifier box.

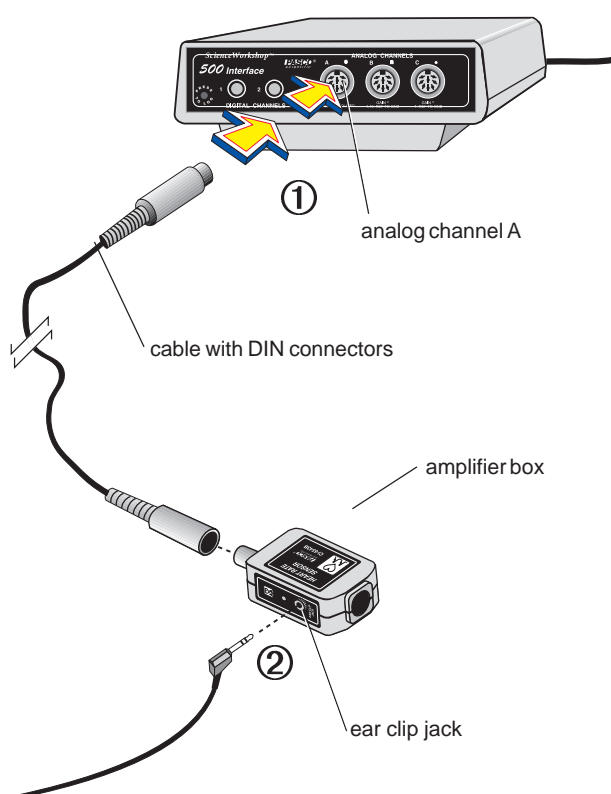


Figure 1
Connecting the amplifier box to the interface box and connecting the ear clip cable to the amplifier box

Setting up Science Workshop

1. Start *Science Workshop*.
2. In the Experiment Setup window, drag the icon for the analog plug to the icon for the channel you are using, and select **Heart Rate Sensor** from the pop-up menu. Click **OK**.
3. Click the **Sampling Options . . .** button, and adjust the sampling rate to 50 Hz by moving the

slider under **Periodic Samples**. Click **OK**.
3. Open a Graph display that plots Heart Rate (beats/minute) vs. Time, by dragging the icon for the Graph display to the Heart Rate Sensor icon, and selecting **Heart Rate (b/m)**. Click **Display**.

4. Open a Digits display that displays Heart Rate (beats/minute) by dragging the icon for the Digits display to the Heart Rate Sensor icon, and selecting **Heart Rate (b/m)**. Click **Display**.
5. Adjust the Digits display to show three digits to the left of the decimal and none to the right by double-clicking the Digits display and typing **3** in the **Digits Left** box and **0** in the **Digits Right** box. Click **OK**.
6. Clip the ear clip to your earlobe and adjust so it is firmly attached. Sit or stand quietly to avoid disturbing the ear clip (Figure 2).

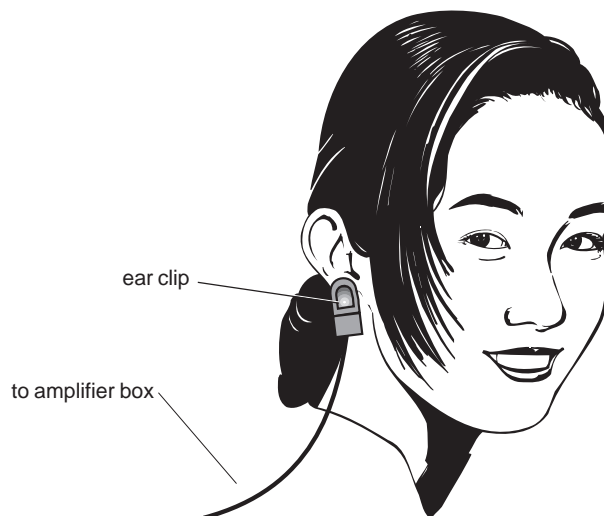


Figure 2
Correct placement of the ear clip

7. Begin monitoring your heart rate by clicking the **MON** button on the Experiment Setup window, choosing **Monitor** from the Experiment menu, or using the keyboard shortcut: **ALT + M** (Windows), **⌘ + M** (Macintosh). Click the **STOP** button to stop monitoring.
8. If the Heart Rate Sensor appears to be working properly, you can begin recording data. However, if the pattern appears jumpy rather than smooth, reposition the ear clip until you see a smooth heart

rate pattern as in Figure 3. If problems persist, consult the *Troubleshooting* section.

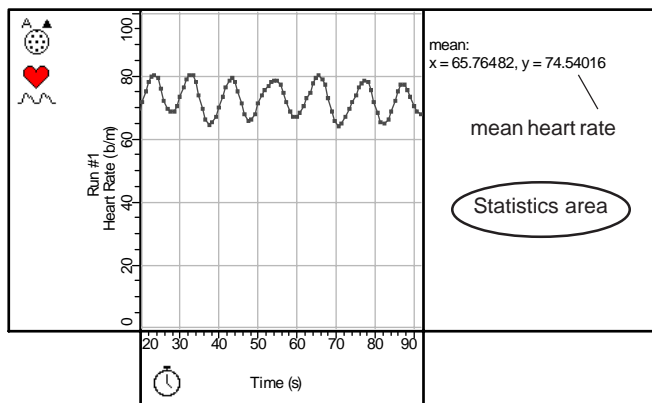


Figure 3

Typical plot of Heart Rate (b/m) vs. Time (as shown on the Graph display)

Recording and Analyzing Heart Rate Data

1. Begin recording your heart rate by clicking the **REC** button on the Experiment Setup window, choosing **Record** from the Experiment menu, or using the keyboard shortcut: **ALT + R** (Windows), **⌘ + R** (Macintosh).
2. Record your heart rate for 60 seconds, and then stop recording by clicking the **STOP** button on the Experiment Setup window, choosing **Stop** from the Experiment menu, or using the keyboard shortcut: **ALT + .** (Windows), **⌘ + .** (Macintosh).
3. Click the **Statistics** button on the Graph display to open the Statistics area of the Graph display.
4. Click the **Statistics Menu** button and select **Mean** from the statistics menu. (The value for the y axis is your average heart rate.)

Note: You may be surprised to note that your heart rate varies over time on the Heart Rate vs. Time Graph display. For example, although your average resting heart rate over a period of 10 seconds may be 70 b/m, your heart rate that is determined moment to moment by the Heart Rate Sensor may vary from 60 b/m to 80 b/m. The amount of variation in heart rate differs among people and under different circumstances.

To calculate your average heart rate that corresponds to the heart rate you would measure by counting your pulse over a period of 10 seconds, drag a box over a 10-second segment of recorded heart rate data on the Graph display and note the mean y-axis value in the statistics area.

For additional information about the natural variability of resting heart rate, see Saini, M. W., et. al., "Correlation of heart rate variability with clinical and angiographic variables and late mortality after coronary angiography," *American Journal of Cardiology* 62: 714–717 (1988).

Displaying Voltage Data

1. To display the voltage recorded or being monitored by the Heart Rate Sensor, click the **Plot Input Menu** button on the Graph Display, and select **Analog A ► Voltage**, or open a new Graph display and select **Voltage** in the **Choose calculations to display** menu. (This voltage corresponds to the variation in light intensity transmitted through the body that results from the pulsating flow of blood through the tissues.)
2. Change the x-axis scale to span a period of 3 or 4 seconds by clicking in the x-axis area and changing the values in the dialog boxes. (The plotted voltage will look similar to that in Figure 4.)

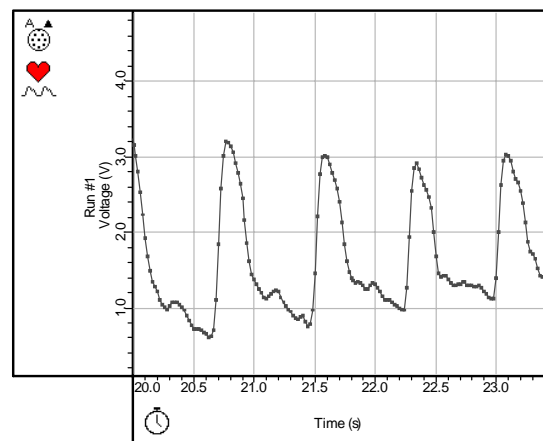


Figure 4

Typical plot of Voltage vs. Time (as shown on the Graph display)

Suggested Activities

1. Record your heart rate at rest and after vigorous exercise. Compare your mean heart rate under these two conditions.
2. Determine your recovery time by recording your heart rate after vigorous exercise until your heart rate returns to the resting rate, and then note the time required.
3. Assume a meditative state and record your heart rate. Next record your heart rate while you have a heated discussion with someone. (Try to keep your head still during data recording.) Compare the pattern of variability in your heart rate under these two circumstances. (Hint: change the scale of the y-axis of the Graph display to a minimum of 50 b/m and a maximum of 110 b/m by clicking in the y-axis area and changing the values in the dialog boxes.)
4. Use two Heart Rate Sensors, connected to analog channels A and B, with the clips fastened to two separate parts of the body (such as ear and finger), to compare the timing of the pulse of blood from the heart in various parts of the body. Set up a Graph display with plots of Voltage vs. Time for analog channels A and B by clicking the **Add-A-Plot** button on the Voltage vs. Time Graph display and selecting **Analog B** ► **Voltage**.

Troubleshooting

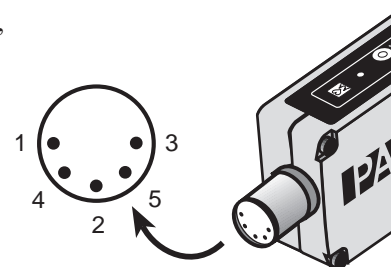
If the system is not functioning properly, try the following:

- Adjust the position of the clip. Try moving the clip to a different part of your ear lobe or perhaps try the tip of one of your fingers or the web of skin between your thumb and index finger.
- Hold still while using the Heart Rate Sensor. If you want to study how exercise affects your heart rate, move around and then stop briefly to get a pulse reading.
- Be patient when using the Heart Rate Sensor. When you move the ear clip, it takes a few seconds for the signal to adjust to the new conditions.

- Let the person being tested sit down, rather than stand up.
- If you are in a room with bright overhead lighting, block some of this light from the clip. Otherwise, it may pick up the flickering of the artificial light, which distorts the signal. Try holding your hand to block the light from the clip.

DIN Connector Specifications

- 1: analog output (+), 0 to 5 V
- 2: analog output (-), signal ground
- 3: (no connection)
- 4: + 5 V DC power
- 5: power ground



Limited Warranty

PASCO scientific warrants the product to be free from defects in materials and workmanship for a period of one year from the date of shipment to the customer. PASCO will repair or replace, at its option, any part of the product which is deemed to be defective in material or workmanship. The warranty does not cover damage to the product caused by abuse or improper use. Determination of whether a product failure is the result of a manufacturing defect or improper use by the customer shall be made solely by PASCO scientific. Responsibility for the return of equipment for warranty repair belongs to the customer. Equipment must be properly packed to prevent damage and shipped postage or freight prepaid. (Damage caused by improper packing of the equipment for return shipment will not be covered by the warranty.) Shipping costs for returning the equipment after repair will be paid by PASCO scientific.

Address: PASCO scientific
10101 Foothills Blvd.
Roseville, CA 95747-7100

Phone: (916) 786-3800
FAX: (916) 786-8905
email: techsupp@pasco.com
web: www.pasco.com