

Heart Rate and Body Position

Does the position of your body affect your heart rate? In this experiment, you will use a Heart Rate Monitor to measure your heart rate while sitting, lying, and standing. You will then use your results to answer the question.

OBJECTIVES

In this experiment, you will

- Use a Heart Rate Monitor to measure your heart rate while sitting, lying, and standing.
- Analyze the results of your experiment.
- Compare your results with those of other students.
- Answer the question posed in the introduction.

MATERIALS

TI-83 Plus or TI-84 Plus graphing calculator
EasyData application
Vernier Hand-Grip Heart Rate Monitor **or**
Vernier Exercise Heart Rate Monitor

data-collection interface
timer
saline solution in a dropper bottle
(only for use with the Exercise HRM)

PROCEDURE

1. Turn on the calculator. Connect the receiver module of the Heart Rate Monitor, data-collection interface, and calculator.
2. Set up EasyData for data collection.
 - a. Start the EasyData application, if it is not already running.
 - b. Select **(File)** from the Main screen, and then select **New** to reset the application.
 - c. Select **(Setup)** from the Main screen, then select **Rate...**
 - d. Select **(Edit)** from the Rate Mode Settings screen.
 - e. Enter **10** as the time between samples in seconds.
 - f. Select **(Next)**.
 - g. Enter **72** as the number of samples and select **(Next)**. Data collection will last 720 seconds (12 minutes).
 - h. Select **(OK)** to return to the Main screen.

3. Set up the Heart Rate Monitor. Follow the directions for your type of Heart Rate Monitor.

Using a Hand-Grip Heart Rate Monitor

- a. Sit in a chair, facing away from the calculator and your classmates. Grasp the handles of the Hand-Grip Heart Rate Monitor your hands. The fingertips of each hand should be placed on the reference areas of the handles. The left hand grip and the receiver are both marked with an alignment arrow. When collecting data, be sure that the arrow labels on each of these devices are in alignment (see Figure 1). The reception range of the plug-in receiver is 80–100 cm, or about 3 feet.

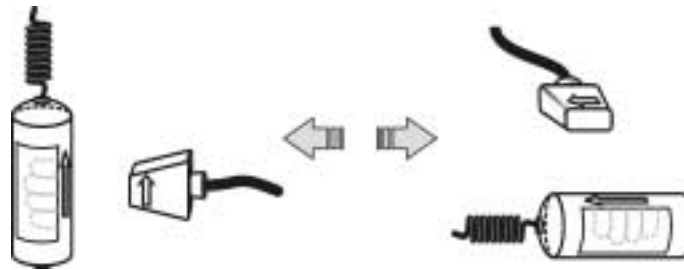


Figure 1

- b. Monitor the live readouts on the calculator screen to determine that the sensor is functioning correctly. There will be a 10–15 second delay while data are collected before the first heart rate is reported. The readings should be consistent and within the normal range of the individual, usually between 55 and 90 beats per minute.
- c. If the readings appear unreasonable, reposition your fingers and check the sensor and receiver alignment.
- d. Once it is apparent that the sensor is functioning correctly, continue with Step 4.

Using an Exercise Heart Rate Monitor

- a. Depending upon your size, select a small or large size elastic strap. Secure one of the plastic ends of the elastic strap to the transmitter belt. It is important that the strap provide a snug fit for the transmitter belt.
- b. Wet each of the electrodes (the two grooved rectangular areas on the underside of the transmitter belt) with 3 drops of saline solution.
- c. Secure the transmitter belt against the skin directly over the base of the rib cage. The POLAR logo on the front of the belt should be centered. Adjust the strap for a tight fit.
- d. Take the receiver module of the Heart Rate Monitor in your right hand and have a seat. Face away from your classmates. Sit quietly. Remember that the receiver must be within 80 cm of the transmitter in the Heart Rate Monitor belt.



Figure 2

Part I Sitting Heart Rate

- Once the subject has been seated quietly and reasonable readings have been obtained for about a minute, a partner should select $\overline{\text{Start}}$ to begin monitoring heart rate. Another partner should begin timing at the same time.

Part II Reclining Heart Rate

- After 4 minutes of data collection have gone by, the subject should recline on a clean surface or table and facing away from all classmates. Note: A partner should tell the subject when it is time to recline.

Part III Standing Heart Rate

- After 8 minutes of data collection have gone by, the subject should stand facing away from all classmates. A partner should again tell the subject when it is time to stand. Data collection will automatically stop after 12 minutes (720 seconds).

Part IV Recording Data

- Examine the graph that is displayed after data collection ends. You should be able to recognize three parts that match with the subject's sitting, reclining, and standing heart rates.
- Determine the subject's sitting heart rate.
 - Select $\overline{\text{Anlyz}}$, and then select **Statistics...**
 - Note the flattest part of the first 1/3 of the graph (up to about 240 seconds) that matches with the sitting part of the experiment.
 - Use $\overrightarrow{\text{D}}$ and $\overleftarrow{\text{C}}$ to move the cursor to the beginning of this flattest part and then select $\overline{\text{OK}}$.
 - Move the cursor to the end of the flat part and select $\overline{\text{OK}}$.
 - Record the mean (average) heart rate (to the nearest whole bpm). This is the subject's sitting heart rate.
 - Select $\overline{\text{OK}}$ to return to the graph.
- Determine the subject's reclining heart rate.
 - Select $\overline{\text{Anlyz}}$, and then select **Statistics...**
 - Note the flattest part of the middle 1/3 of the graph (from about 240 seconds up to about 480 seconds) that matches with the reclining part of the experiment.
 - Use $\overrightarrow{\text{D}}$ and $\overleftarrow{\text{C}}$ to move the cursor to the beginning of this flattest part and select $\overline{\text{OK}}$.
 - Move the cursor to end of this flat part and select $\overline{\text{OK}}$.
 - Record the mean (average) heart rate (to the nearest whole bpm). This is the subject's reclining heart rate.
 - Select $\overline{\text{OK}}$ to return to the graph.
- Determine the subject's standing heart rate.
 - Select $\overline{\text{Anlyz}}$, and then select **Statistics...**
 - Note the flattest part of the last 1/3 of the graph (from about 480 seconds up to 720 seconds) that matches with the standing part of the experiment.
 - Use $\overrightarrow{\text{D}}$ and $\overleftarrow{\text{C}}$ to move the cursor to the beginning of this flattest part and select $\overline{\text{OK}}$.
 - Move the cursor to end of this flat part and select $\overline{\text{OK}}$.
 - Record the mean (average) heart rate (to the nearest whole bpm). This is the subject's standing heart rate.
 - Select $\overline{\text{OK}}$ to return to the graph.

11. Sketch or print copies of the graph as directed by your teacher.
12. Repeat Steps 4–11 with other members of the team serving as subjects. Note: After selecting **(Start)**, select **(OK)** to begin data collection.

DATA

Subject's name			
Sitting heart rate (beats/min)			
Reclining heart rate (beats/min)			
Standing heart rate (beats/min)			
Difference between sitting and reclining heart rates (beats/min)			
Difference between standing and sitting heart rates (beats/min)			
Difference between standing and reclining heart rates (beats/min)			

PROCESSING THE DATA

1. In the space provided in the data table, subtract to calculate the difference between the sitting and reclining heart rates for each subject.
2. Subtract to find the difference between the standing and sitting heart rates for each subject.
3. Subtract to find the difference between the standing and reclining heart rates for each subject.
4. Does the position of your body affect your heart rate?

5. Compare your results with those of other students.

6. Try to explain the results of the experiment.

EXTENSION

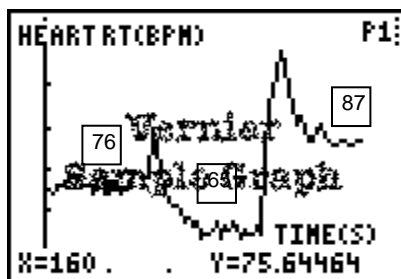
1. Measure your heart rate while standing on your head. Compare the results with your other results.

TEACHER INFORMATION**Heart Rate and Body Position**

1. There are several different combinations of equipment that will work for measuring heart rate. The most common method, which uses the USB port on TI-84 Plus calculators, is to connect a Heart Rate Monitor to an EasyLink. For more information on EasyLink refer to Appendix A.

The other method, which works for both the TI-83 Plus and TI-84 Plus families of calculators, is to use a Heart Rate Monitor attached to a LabPro or CBL 2.

2. This experiment works equally well with either a Hand-Grip Heart Rate Monitor or an Exercise Heart Rate Monitor.
3. The receiver module of either type of Heart Rate Monitors will receive signals from the closest transmitter source. To avoid confusion or erroneous readings, have the test subjects from different lab teams stay at least 2 m apart.
4. It is possible to alter your heart rate by simply decreasing your respiratory rate and relaxing. Encourage students to stay alert and to breathe normally.
5. The Exercise Heart Rate Monitor includes a transmitter belt, receiver module, large elastic strap, and small elastic strap.
6. It is important to have good contact between the transmitter belt and the test subject when using the Exercise Heart Rate Monitor. It is very important that the belt fit snug, but not too tight. Both electrodes should be wetted with either saline solution or contact lens solution. A 5% salt solution works well and can be prepared by adding 5 g per 100 mL of solution. Typical symptoms of inadequate contact with the electrodes are a noisy signal with erroneous peaks, missing heart beat rates, or a flat-line display. If the students receive a flat reading with no heart rate detected, have them move the transmitter and the receiver closer together. The range of the transmitter in the chest belt is 60 to 80 cm.

SAMPLE RESULTS

Heart Rate and Body Position

Experiment 25

Subject's name	Larissa	Rebekka	Chris
Sitting heart rate (beats/min)	xxxx	xxxx	xxxx
Reclining heart rate (beats/min)	xxxx	xxxx	xxxx
Standing heart rate (beats/min)	xxxx	xxxx	xxxx
Difference between sitting and reclining heart rates (beats/min)	xxxx	xxxx	xxxx
Difference between standing and sitting heart rates (beats/min)	xxxx	xxxx	xxxx
Difference between standing and reclining heart rates (beats/min)	xxxx	xxxx	xxxx

ANSWERS TO QUESTIONS

Answers have been removed from the online versions of Vernier curriculum material in order to prevent inappropriate student use. Graphs and data tables have also been obscured. Full answers and sample data are available in the print versions of these labs.

ACKNOWLEDGMENT

We wish to thank Kelly Redding and David Masterman for their help in developing and testing this experiment.