



Our Heart Rate:
Measuring Our Heart Rate
at Rest and During Physical Exercise
(Teacher's Guide)

OVERVIEW

Students will measure their heart rhythm at two different times (during rest and after physical exercise) using the Ward's DataHub heart rate sensor, to discover how these two data are related. After this activity, they will construct two graphs and observe the differences in order to compare the results with their initial hypothesis.

MATERIALS NEEDED

Ward's DataHub
USB Cable Connector*
Ear Clip

* – *The USB connector cable is not needed if you are using a Bluetooth enabled device.*

NUMBER OF USES

This demonstration can be performed repeatedly.

FRAMEWORK FOR K-12 SCIENCE EDUCATION © 2012

* The Dimension I practices listed below are called out as **bold** words throughout the activity.

Dimension 1 Science and Engineering Practices	✓	Asking questions (for science) and defining problems (for engineering)		Use mathematics and computational thinking
		Developing and using models	✓	Constructing explanations (for science) and designing solutions (for engineering)
	✓	Planning and carrying out investigations		Engaging in argument from evidence
	✓	Analyzing and interpreting data	✓	Obtaining, evaluating, and communicating information

Dimension 2 Cross Cutting Concepts		Patterns		Energy and matter: Flows, cycles, and conservation
		Cause and effect: Mechanism and explanation	✓	Structure and function
		Scale, proportion, and quantity		Stability and change
	✓	Systems and system models		

Dimension 3 Core Concepts	Discipline	Core Idea Focus
	Life Science	LS1: From Molecules to Organisms: Structures and Processes
		LS1.A: Structure and Function
		LS1.B: Growth and Development of Organisms

NGSS Standards	Middle School Standards Covered	High School Standards Covered
	MS.LS-SFIP: Structure, Function, and Information Processing	HS.LS-SFIP: Structure, Function, and Information Processing
	MS.LS-GDRO: Growth, Development and Reproduction of Organisms	HS.LS-IVT: Inheritance and Variation of Traits

NATIONAL SCIENCE EDUCATION STANDARDS © 2002

Content Standards (K-12)			
✓	Systems, order, and organization		Evolution and equilibrium
✓	Evidence, models, and explanation		Form and Function
✓	Constancy, change, and measurement		

Life Science Standards Middle School		Life Science Standards High School	
✓	Structure and Function in Living Systems		The Cell
	Reproduction and Heredity		Molecular Basis of Heredity
✓	Regulation and Behavior		Biological Evolution
	Populations and Ecosystems		Interdependence of Organisms
✓	Diversity and Adaptations of Organisms	✓	Matter, Energy, and Organization in Living Systems
		✓	Behavior of Organisms

✓ Indicates Standards Covered in Activity

LEARNING OBJECTIVES

Core Objectives (National Standards):

- Develop the ability to refine ill-defined questions and direct to phenomena that can be described, explained, or predicted through scientific means.
- Develop the ability to observe, measure accurately, identify and control variables.
- Decide what evidence can be used to support or refute a hypothesis.
- Gather, store, retrieve, and analyze data.
- Become confident at communicating methods, instructions, observations, and results with others.

Activity Objectives:

The objective of this activity is to study our heart rate at rest and after physical exercise. Students will create a hypothesis and proceed to test it, using the Ward's DataHub heart rate sensor.

Time Requirement:

45–60 minutes

VOCABULARY

Aorta: The largest artery in the body, which delivers blood from the heart to the rest of the body.

Artery: A blood vessel that carries blood away from the heart to the rest of the body.

Atrium: One of the upper two hollow chambers of the heart that collects blood as it enters the heart and before it is pumped to the ventricles.

Blood: A fluid found in humans and other animals which provides nutrients and oxygen to all parts of the body.

Blood Pressure: The measure of how hard blood is pushing against the walls of your arteries.

Circulation: The movement of blood through the vessels.

Diastolic Blood Pressure: The lowest blood pressure, measured in the arteries when the heart muscle is relaxed between beats.

Heart: The muscular organ that pumps your blood around your body.

Heart Rate (Rhythm): Another term for a heartbeat. The number of times the heart beats in a minute. A normal heart rate ranges from 60 to 100 beats per minute at rest.

Stethoscope: An instrument used to listen to sounds from the heart and lungs.

Systolic Pressure: The blood pressure during the contraction of the left ventricle of the heart.

Ventricle: One of the two lower chambers of the heart. The right ventricle sends blood to the lungs, and the left ventricle sends blood carrying oxygen to the rest of the body. The ventricles are the main pumping chambers of the heart and they contract at the same time.



Teacher Notes

INTRODUCTION

Even though we know our heart beats throughout our entire life, we don't usually notice it while resting or sitting. However, whenever we make a greater physical effort, we can feel our heart pounding strongly inside our chest.

- **What other situations do you think can cause your heart pulse to rise?**
- **What do you think would happen if our heart didn't have the ability to adapt?**

Carry out the experiment activity with your class so that at the end students will be able to answer the following questions:

- **In what type of situations does our heart rate rise? In what type of situations does our heart rate slow down?**

BACKGROUND

One of our vital functions is to provide each part of our body with gases, hormones and nutrients. This is performed by our circulatory system. The fundamental organ in this system is the heart, a very special muscle which has the ability to control itself. It works like a pump, receiving blood from the veins and ejecting it through the arteries.

The blood arrives into the atria and then flows into the ventricles. From here, the ventricles pump the blood out of the heart, carrying it throughout our body.

Every cardiac cycle has two phases: Contraction (systole phase) and relaxation (diastole phase). These movements don't happen at the same time, but we can explain the cycle with these three events:

Atrial systole: Both atria contract, ejecting the blood into the ventricles.

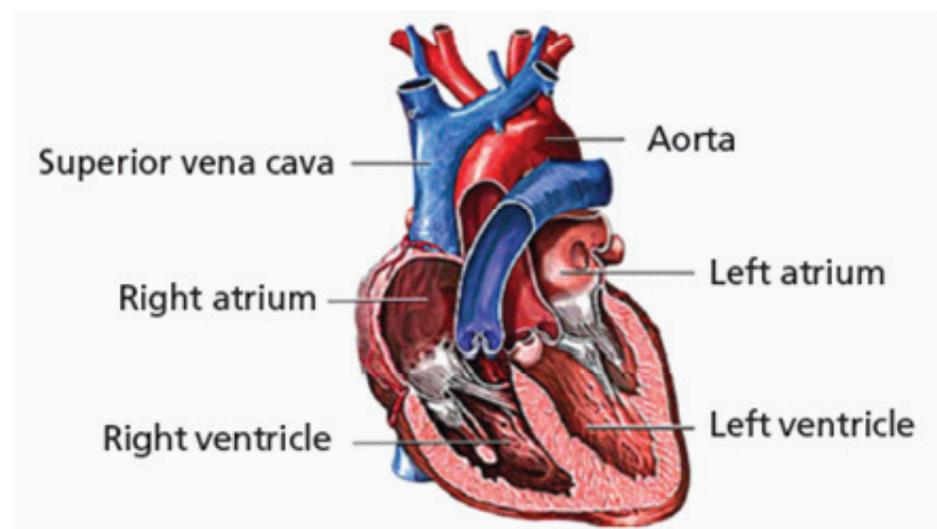


FUN FACTS:

1. The heart only weighs on average 11 ounces.
2. A healthy heart pumps 2,000 gallons of blood through 60,000 miles of blood vessels each day.
3. An average adult heart beats 72 times per minute. This equals 100,000 times a day 3,600,000 times a year and 2.5 *billion* times during a lifetime!
4. A newborn baby has only about 1 cup of blood in their body, while an adult has between four and five quarts.
5. Every day, the heart creates enough energy to drive a truck 20 miles, which in a lifetime, would equal driving to the Moon and back!

Ventricular systole: Both ventricles contract ejecting the blood outside the heart. Meanwhile, the atria are still in systole. The right ventricle contains the blood collected by the veins from all over the body. This blood has a high concentration of CO_2 and a low concentration of O_2 . From the right ventricle the blood is pumped to the lungs, where oxygenation takes place. The left ventricle expels the blood that comes from the lungs, meaning this blood is rich with O_2 and contains only a little amount of CO_2 .

General diastole: Atria and ventricles relax, letting the blood enter inside the atria again.



Now encourage students to raise a hypothesis which must be tested with an experiment. Students may find it helpful to formulate their hypothesis as an answer to the following question.

- **If you were to measure your heart rate at rest and then again after performing physical exercise, how much do you think it would rise?**

CONNECTING THE WARD'S DATAHUB TO A COMPUTER

If you are using a Bluetooth communication device:

Right-click on the Bluetooth icon in the lower right corner of the screen and select the Ward's DataHub you are using. The icon will change from gray to blue, as shown at right, indicating that the Ward's DataHub and the computer are now connected via Bluetooth.



If you are using a USB communication device:

In order to use USB communication, connect the Ward's DataHub and the computer with the USB cable supplied. Click on the USB icon at the lower right corner of the screen. This icon will change from gray to blue, as shown at right, indicating that the Ward's DataHub is connected to the computer via USB.



USING THE WARD'S DATAHUB



= Select key



= On/Off and Escape key



= Scroll key

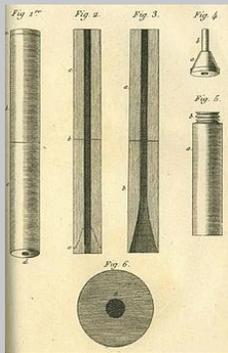
To collect measurements with the Ward's DataHub, it must first be configured as follows:

1. Turn on the Ward's DataHub by pressing the On/Off/Esc key.		8. Press the On/Off/Esc key to return to the setup menu.	
2. Go to setup by using the Scroll key; then select Setup by pressing the Select key.	 then 	9. Press the Scroll key to highlight the Number of Samples and then press the Select Key.	 then 
3. Select the Set Sensors option by pressing the Select key.		10. Press the Scroll key until "1000" is highlighted, then press the Select key.	 then 
4. If any sensor(s) appear on the screen, press the key representing that sensor to deactivate it. Once you have a blank window, press the Heart Rate Sensor key once .		11. Press the On/Off/Esc key three times to return to the main operating screen.	 x 3
5. Press the On/Off/Esc key once to return to the setup menu.		12. Press the Select key to start measuring. (You are collecting data when there is an icon of a Runner in the upper left hand corner of the screen.)	
6. Press the Scroll key to highlight the Sampling Rate and then press the Select Key	 then 	13. Once you have finished measuring, stop the Ward's DataHub by pressing the Select key, followed by the Scroll key.	 then 
7. Press the Scroll key until "10/sec" is highlighted, then press the Select key.	 then 		



DID YOU KNOW?

The stethoscope was invented in 1816 by French physician Rene Laennec. He felt it was inappropriate to place his ear on the chests of his female patients.

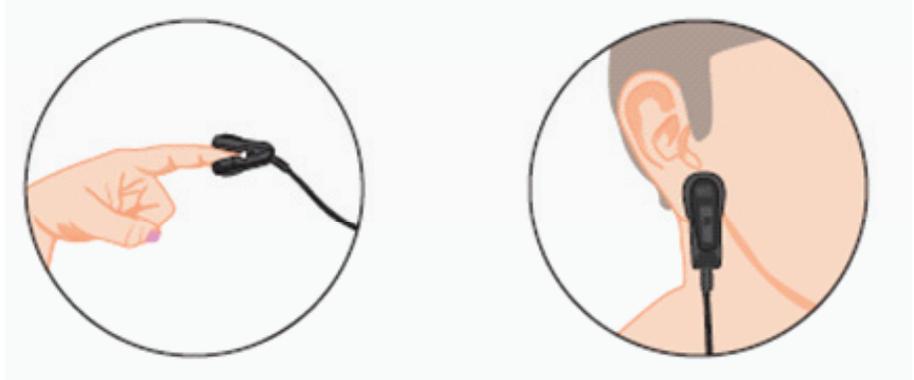


The First Drawings of a Stethoscope.



ACTIVITY

1. Put the ear clip on the index finger of a student and start recording with the Ward's DataHub, as the image below shows. After a few seconds, the Ward's DataHub should produce a "beeping" sound for every heartbeat. If this does not happen, put the ear clip on the student's earlobe, as shown below.

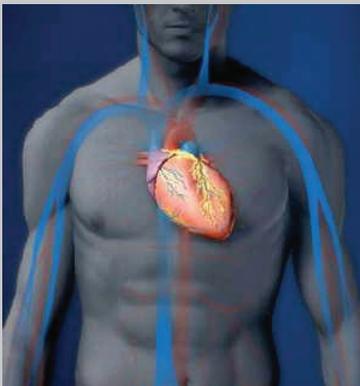


2. The student should stay sitting calmly, without talking for 1 minute. Then stop the Ward's DataHub.
3. Following the first minute, the student should then stand up and start jumping for another minute. After that, put the ear clip on the student's index finger (or ear) and start recording with the Ward's DataHub for another minute.
4. Once you've finished measuring, stop the Ward's DataHub.
5. Repeat the same procedure with other classmates who want to participate.



DID YOU KNOW?

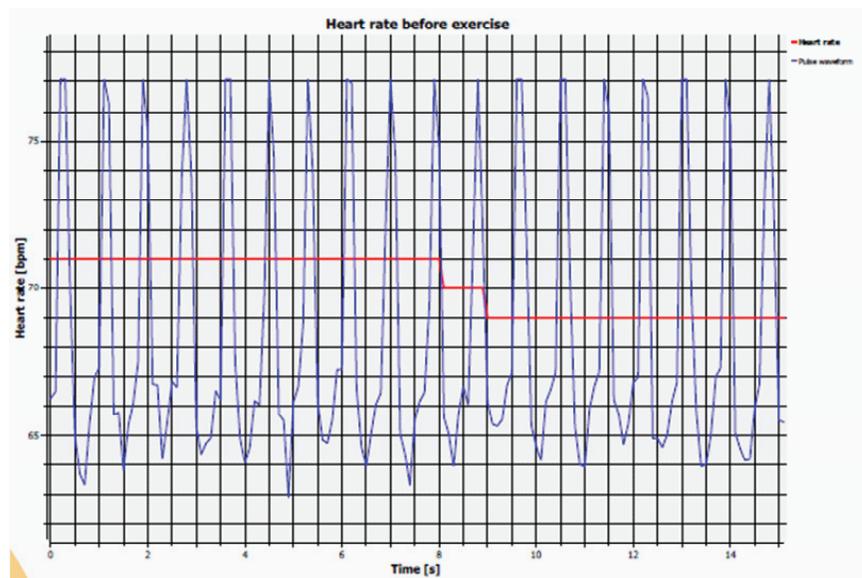
What side of your body is your heart on? Most people locate their heart by placing their hand on their left chest. Your heart is actually located in the center of your chest between your lungs. It is tilted slightly to the left, and that is why you feel it beating more on the left side.



RESULTS AND ANALYSIS

1. Connect the Ward's DataHub to the computer using the Bluetooth wireless communication channel or USB connector.
2. In the top menu, click on the  button and select the  button.
3. Select the last experiment from the list if you measured the heart rate of a single student. If you collected data from more students, proceed to analyze the graphs one-by-one. Remember that there are two graphs per student.
4. Observe the graph displayed on the screen.
5. Press the  button and write notes on the graph specifying at what range you found the data for rest and physical exercise.
6. Press  to select data points on the graph and pick one representative point for each activity.
 - **Did you find differences between your hypothesis and the results recorded with the sensor? Explain.**
 - **What can cause the rise in the heart rate during physical exercise?**
 - **What other factors could relate to heart rate variations in a person?**

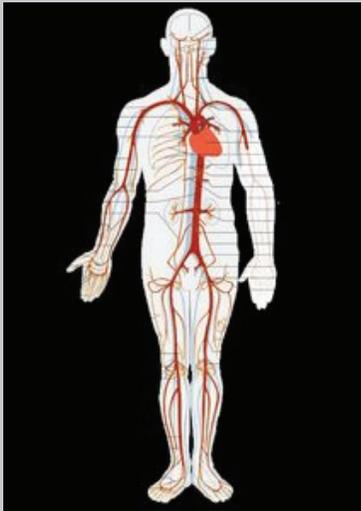
The graph below should be similar to the students' graph.





DID YOU KNOW?

At rest, it takes 6 seconds for blood to go from the heart to the lungs and back again, and 8 seconds to go to the brain and back. Amazingly, it takes only 16 seconds for blood to reach the toes and travel back to the heart.



CONCLUSIONS AND ASSESSMENTS

1. Did you find a correlation between the activity of the person and the heart rate you recorded? **Explain.**

The student should point out that the heart rate rises with physical exercise, compared to the heart rate during a period of rest.

2. Do all people have the same heart rate during a period of rest? **Argue** why or why not.

Students should compare the graphs of two or more classmates, and establish that two people don't have the same heart rate, even if both are resting.

3. If you **compare** both graphs, how does the pulse vary at rest, during exercise and when returning to rest?

Students should compare the graphs and say that the pulse remains constant when resting, increases during exercise and returns to the initial value when returning to rest.

Students should reach the following conclusions:

The heart rate is a physiological parameter that varies depending on the condition (at rest or performing physical exercise), and that it is also variable between different people in the same condition. They should also understand that heart rate is related to the individual person's health condition.

ACTIVITIES FOR FURTHER APPLICATION



DID YOU KNOW?

Werner Forssmann was a German surgeon who in 1929 examined the inside of his own heart. He did this by threading a catheter into his arm vein and pushing it 20 inches up into his heart. This procedure is now a very common surgical procedure called cardiac catheterization.



The aim of this section is for students to extrapolate the acquired knowledge during this lesson through its application in different contexts and situations. Furthermore, it is intended that students question and present possible explanations to the experimentally observed phenomena.

Further Questions

1. Whenever we exercise, our muscles consume a lot of oxygen and in turn start releasing more CO_2 than when we are resting. How do you think these two actions are related to our heart rate?

Students should understand that the heart rate rises during exercise, because we need to pump more oxygenated blood towards the muscles, so that they can keep performing well. Additionally, an increased blood flow removes the large amount of CO_2 that is released during muscle activity, transporting it to the lungs.

2. Do you think heart rate varies with age? (Think about a fetus, babies, kids, adults, and elderly people).

Students should find out that as we get older, our heart rate slows down. Maybe some of the students have felt the heartbeat of a newborn and noticed its heart rate is much higher.

3. Why do you think that it is important to know someone's heart rate?

Students should understand that heart rate is an important variable to consider in determining if someone is sick or healthy, because it will change often during some illness or in relation to symptoms (such as fever).

4. Do you know how our daily diet, particularly the amount of fat consumed, can relate to our heart rate?

Students should establish that fat consumption causes blood vessel blockages, and therefore changes the heart rate.

5. Surely you have noticed that your heart rate rises when you are scared or feeling strong emotions; do you know why this happens? If you don't, investigate the reason.

Students should establish that heart rate changes because of different hormones which are released into the blood stream. For example, adrenaline is a heart rate rising hormone that is released during physical activity and in stressful situations.

6. When you compare both graphs obtained, how do you explain that the pulse value returned to the same value as before doing exercise?

Students should point out that during exercise, the body needs more oxygen than when in a resting state. As a result, the heart pumps more blood to the tissues that are working and the pulse increases, but at rest the blood flux decreases, so the heart pumps less and the pulse returns to the initial state.

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- **What other situations do you think can cause your heart pulse to rise?**
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After carrying out this experiment, you should be able to answer the following questions:

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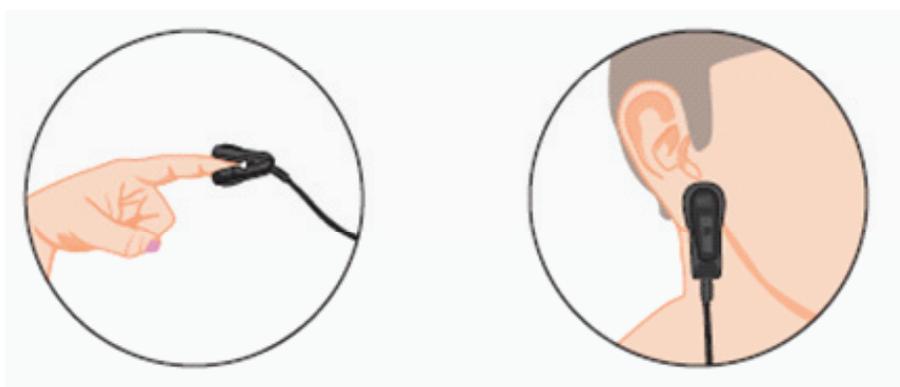
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CONCLUSIONS AND ASSESSMENTS

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2. Do all people have the same heart rate during a period of rest? **Argue** why or why not.

3. If you **compare** both graphs, how does the pulse vary at rest, during exercise and when returning to rest?

4. Write a concluding paragraph describing what you **observed** during the experiment.
