
Experiment B-40 Electrocardiogram Measurement



Objectives

- To learn about the electrical activity of the heart.
- To study the principles of an ECG measurement.
- To compare normal ECG graphs to those of people with heart conditions.

Modules and Sensors

- PC + NeuLog™ application
- USB-200 module 
- NUL-218 electrocardiogram logger sensor 

Introduction

The heart is a muscular organ that pumps blood to the body. Besides the heart, the circulatory system consists of arteries, veins and capillaries. The blood is pumped by the contraction of the heart's walls. Blood carries oxygen and nutrients to cells in the body, and carbon dioxide to the lungs (for exhalation). Humans have a four chambered heart which includes the right atrium, left atrium, right ventricle and left ventricle.

The heart consists of myocytes also known as muscle cells. Each myocyte is surrounded by a cell membrane called sarcolemma. A single myocyte beats when a complex series of ion channels on the sarcolemma open and close in an organized manner, letting different ions flow in and out of the membrane.

When a myocyte beats, sodium (Na^+) channels open allowing a rapid flow of Na^+ ions into the cell. After about 2 milliseconds, the channel closes; this is called depolarization (positive ions enter the cell). Then potassium (K^+) is slowly released to the outside of the cell through a potassium channel; this is called repolarization (positive ions move out of the cell). This event, in which the electrical membrane potential rapidly rises and falls, is called an action potential.

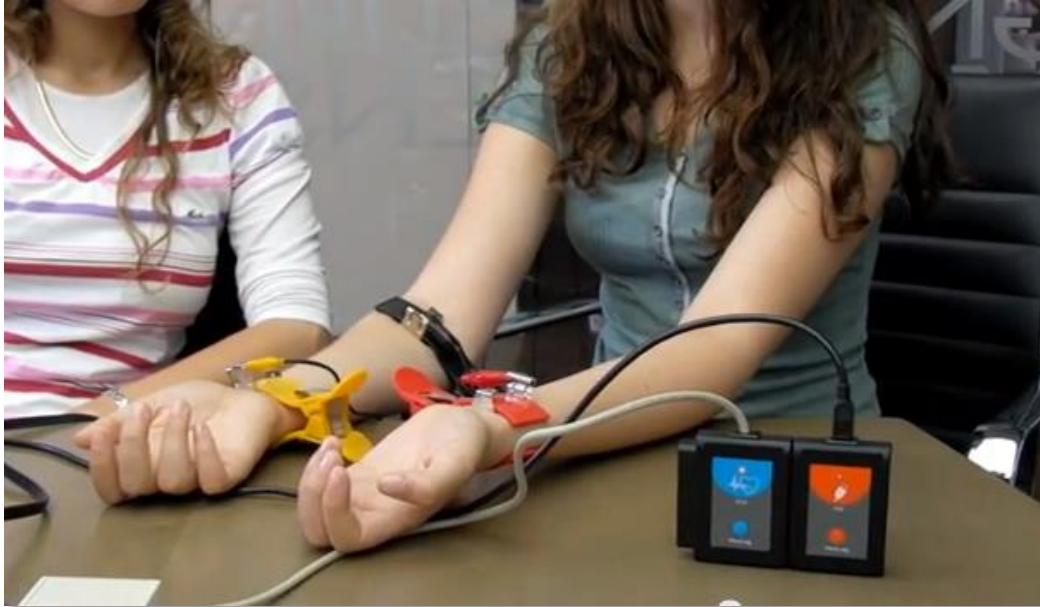
The synchronized electric sequence of the heart is initiated by the heart's natural pacemaker, the SA node. It sends out an electrical impulse to the right atrium, left atrium and AV node simultaneously. The SA node is located in the right atrium, therefore it depolarizes before the left atrium. The depolarization causes atrial contraction. The ventricle fills up with blood and then the AV node sends the impulse to the Bundle of His and the Purkinje fibers, causing the contraction of the ventricles (in order to pump blood to the lungs and to the body). This electrical activity of the heart can be detected by the ECG's electrodes attached to the body surface.

In this activity, we will use an electrocardiogram logger sensor in order to get a classical ECG graph and analyze it.

Procedure

Experiment setup

1. Set up the experiment as shown in the picture below.





2. Remove any metal objects (jewelry, belts, etc) from your body.
3. Attach the sensor's crocodile clips to the metal part of the hand clips, as in the picture above.
4. Place your arms with the palms facing up.
5. When you attach the clips to your hands, the metal surface should be attached to the upper side of the hands.
6. Attach the red clip to your left wrist.
7. Attach the yellow clip to your right wrist.
8. Attach the black clip to your right arm; somewhere between the elbow and a few centimeters above the yellow clip (you can make a measurement with each clip position to choose the best one).

Note:

The electrocardiogram logger sensor is designed for educational use only and may not be used for medical diagnose.

Sensor setup


9. Connect the USB-200 module  to the PC.
10. Check that the electrocardiogram sensor  is connected to the USB-200 module.

Note:

The following application functions are explained in short. It is recommended to practice the NeuLog™ application functions (as described in the user manual) beforehand.

11. Run the NeuLog™ application and check that the electrocardiogram sensor is identified.


Settings

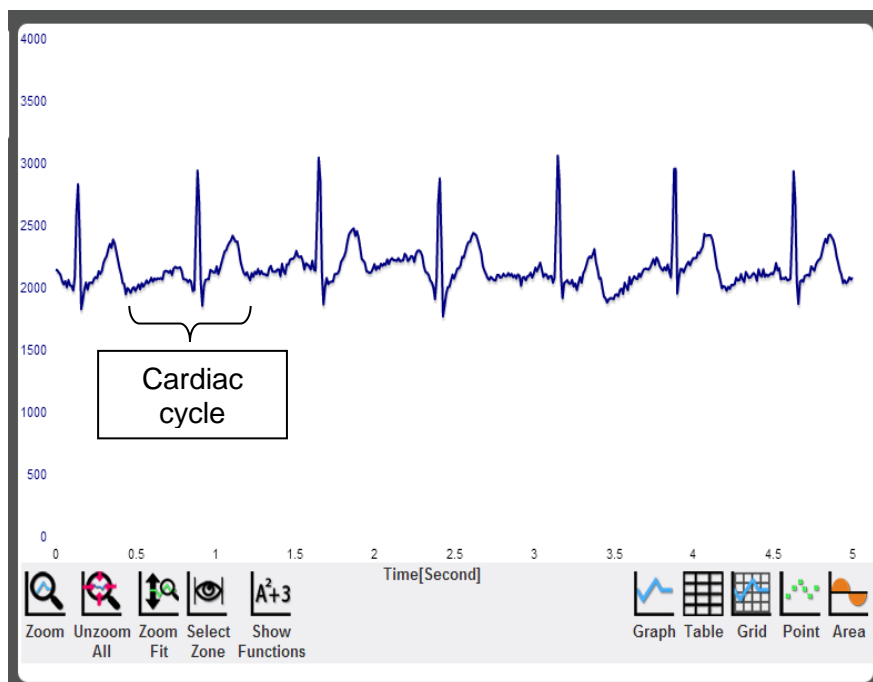
12. Click on the **Run Experiment** icon  and set the:
Experiment duration to 5 seconds
Sampling rate 100 per second

Testing and measurements


Note:

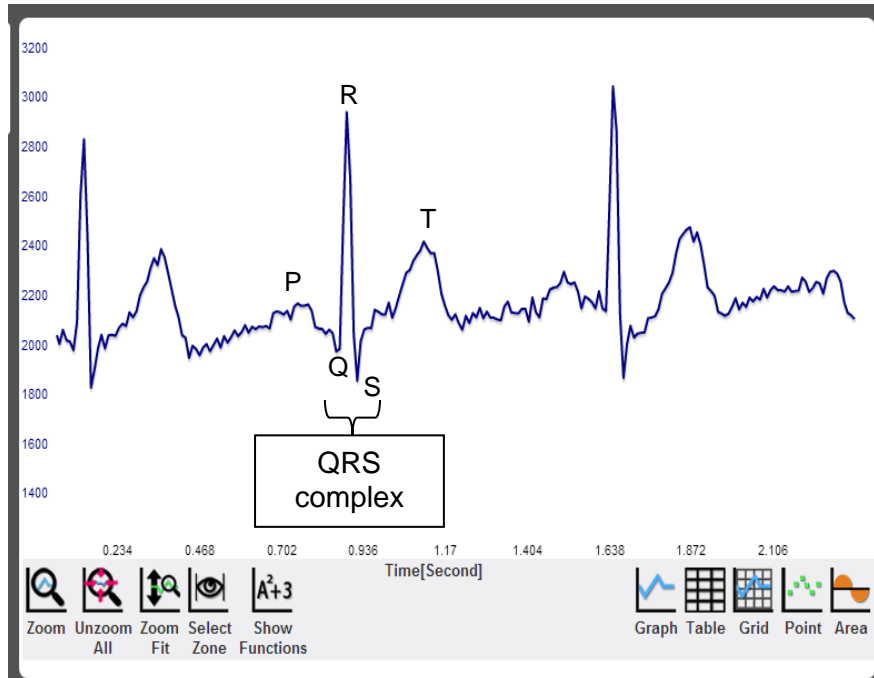
This experiment should be carried out in pairs.

13. It is important that the student whose ECG is being taken remains still during the measurement.
14. When you are ready, click on the **Record** icon  to start the measurement.
15. Your graph should be similar to the following:



16. Save your graph.
17. Each repetitive segment represents a cardiac cycle (a heartbeat). In order to analyze the graph, select a segment of three heartbeats.

18. In order to focus on the desired range, click on the **Zoom** icon , locate the mouse cursor at a point above the graph and press its left button; keep it pressed and create a rectangle that includes the whole range.



19. The electrocardiogram is composed of waves and complexes. The **P wave** is caused by atrial depolarization. Contraction begins at about the middle of it and continues during the PR segment. The **PR segment** (from the end of the P wave to the beginning of the QRS complex) corresponds to the time in which the impulse travels from the AV node towards the ventricles. The **QRS complex** represents the depolarization of the ventricles. Contraction of the ventricles begins at about half way through it and continue up to the end of the T wave (blood starts to pump at the end of this complex). The **T wave** represents the rapid ventricular repolarization. Other important segments are the **PR interval**, the **ST segment** and the **QT interval**.

Challenge research

20. Measure the ECG of other students in your group and compare graph patterns and heart rates.
21. Do some exercise and then repeat the experiment. Did the graph change?

Summary questions

1. Mark the P wave, the QRS complex and the T wave on your ECG graph.
2. Find an ECG graph of a person with a heart disease or condition on the internet (for example a heart attack or ventricular fibrillation). Compare that graph to a normal one.
3. Heart disease can also be diagnosed through other methods. Describe one of these methods.