
Activity 4.2.3: EKG

The following is used with permission of Vernier Software and Technology. This activity is based on the experiment “Analyzing the Heart with EKG” from the book *Human Physiology with Vernier*, written by Diana Gordon and Steven L. Gordon, M.D.

Introduction

Human body systems depend upon electrical impulses to send and receive messages. Electrical energy is what directs and choreographs the rhythmic beating of your heart. Each beat is initiated by an electrical signal. This electrical activity can be monitored and recorded in the form of a graph. The graph made in this process is called an *electrocardiogram* and is abbreviated as EKG or ECG. Medical professionals are trained to study an EKG and use the graphical display to diagnose heart abnormalities such as irregular heartbeat, irregular speed of contractions, angina (chest pain that can indicate tissue damage), or even tissue death (myocardial infarction, also known as a heart attack).

In this experiment you will use the EKG sensor to make a graphical recording of your heart’s electrical activity. You will identify the different components of the waveforms and use them to determine your heart rate. You will also analyze Anna’s EKG readings in her cardiac workup and investigate how the function (or dysfunction) of her heart may have played a role in her death.

Equipment

- Project 4.2.1 Medical History Resource Sheet
- Computer with Vernier Logger *Pro*[®] Software and Internet access
- Vernier LabQuest Mini[®]
- Vernier EKG Sensor
- Markers or colored pencils
- Heart box diagram from Activity 4.1.1
- Timer or watch
- Graph paper
- Laboratory journal
- PBS Course File

Procedure

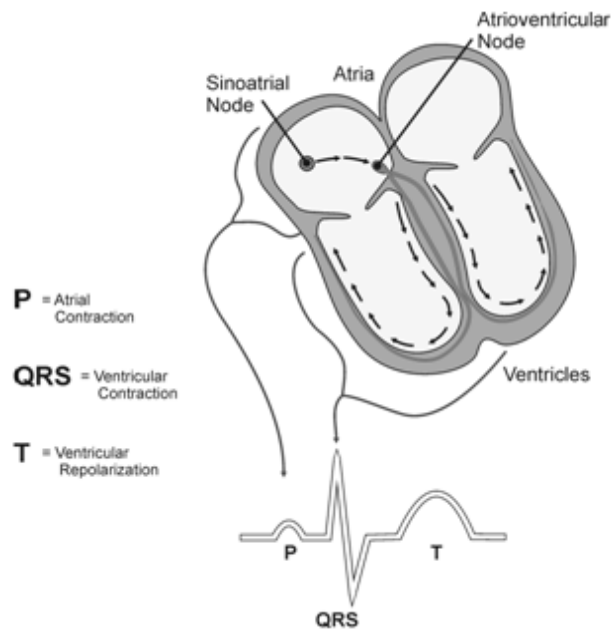
1. Note that contraction of the heart muscle is involuntary. It happens without you thinking about it. Use the websites below to investigate the conduction system of the heart, the structures that “keep the beat.” Pay attention to how what is happening in the heart relates to the electrocardiogram (EKG). **Take notes in your NB.**
 - National Institutes of Health – Your Heart’s Electrical System
<http://www.nhlbi.nih.gov/health/health-topics/topics/hhw/electrical.html>

- McGraw Hill – Conducting System of the Heart animation
https://highered.mcgraw-hill.com/sites/0072495855/student_view0/chapter22/animation__conducting_system_of_the_heart.html
 - MyHeartCentral.com – Intrinsic Conduction System of the Heart
<http://www.healthcentral.com/heart-disease/animation-44725-71.html>
 - Look through the class notes on 4.2.3. EKG. It can be found on the class website.
2. Take out your heart box drawing from Activity 4.1.1.
 3. Use a yellow marker or colored pencil to add the main structures of the conduction system (listed below) on your diagram.
 - Sinoatrial (SA) node
 - Atrioventricular (AV) node
 - Atrioventricular (AV) bundle (bundle of His)
 - Bundle branches
 - Purkinje fibers
 4. Use your yellow marker or colored pencil to draw the path of the electrical signal in the heart.
 5. Read the information below about EKGs. Pay attention to how the shape of an EKG tracing relates to the information about conduction you learned in Step 1.

An electrocardiogram (ECG or EKG) is a graphical recording of the electrical events occurring within the heart. In a healthy heart, there is a natural pacemaker in the right atrium (the sinoatrial node) which initiates an electrical sequence. This impulse then passes down natural conduction pathways between the atria to the atrioventricular node and from there to both ventricles. The natural conduction pathways facilitate orderly spread of the impulse and coordinated contraction of first the atria and then the ventricles. The electrical journey creates unique deflections in the EKG that tell a story about heart function and health (Figure 1).

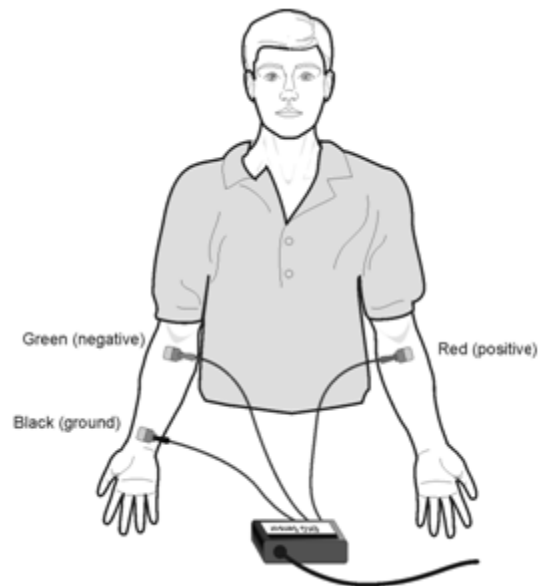
The electrodes of the EKG sensor detect the electrical current in the hearts' cells. The electrodes detect the electrical impulse being produced by the heart by detecting the difference between the charges in the areas where the electrodes are attached. The greater the intensity of the impulse, the greater the difference in the charges, and the larger the upward or downward peak will appear on the EKG.

Figure 1:




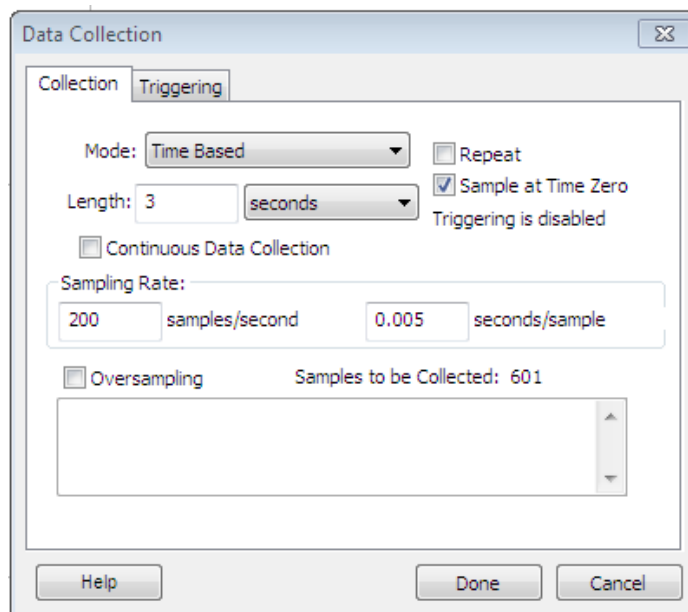
Five components of a single beat are traditionally recognized and labeled P, Q, R, S, and T. The P wave represents the start of the electrical journey as the impulse spreads from the sinoatrial node downward from the atria through the atrioventricular node and to the ventricles. Ventricular activation is represented by the QRS complex. The T wave results from ventricular repolarization, which is a recovery of the ventricular muscle tissue to its resting state. By examining several beats, you can calculate the rate for each component.

6. Draw the EKG tracing shown above on your heart box poster. Label the P wave, QRS complex, and the T wave. Next to each label, draw a text box that explains how this wave or complex relates to heart function – think about what is contracting or relaxing during this part of the tracing and where the signal is being sent. Make sure to mention the relevant structures of the conduction system.
7. Note that you will now take an EKG of your own heart. Note: This EKG is not to be used for diagnostic purposes.
8. Watch your teacher demonstrate how to connect the equipment and open the Logger Pro® program to take an EKG.
9. Refer to the Logger Pro® resource sheet as needed throughout the experiment.
10. Start the Logger Pro® software and open the *Human Physiology with Vernier* folder. Open experiment *12 Analyzing Heart EKG*.
11. Connect the LabQuest Mini to the computer using the USB cable.
12. Connect the EKG Sensor into *CH 1* of the LabQuest Mini.
13. Attach three electrode tabs to your arms, as shown below. Place a single patch on the inside of the right wrist, on the inside of the right upper forearm (below the elbow), and on the inside of the left upper forearm (below the elbow).



14. Connect the EKG clips to the electrode tabs as shown in the diagram above. Sit in a relaxed position in a chair, with your forearms resting on your legs or on the arms of the chair. Because muscle movement also involves electrical activity, it is important to remain still while the EKG is being recorded. Muscle movement will interfere with the EKG sensing and will cause artifacts in the graph.

15. Click on the Data Collection icon  and set the *Length* to 3 seconds. Set the *Sampling Rate* to 200 samples/second. Click done.



16. Click the green *Collect* arrow in the top toolbar.
17. Notice that data is plotted on the graph.
18. Save your data to a file as instructed by your teacher.
19. Copy Table 1 below into your laboratory journal.

Table 1	
Interval	Time (s)
P-R	
QRS	
Q-T	
R-R	

20. Examine the diagram below to determine the specific waves, intervals, and complexes.

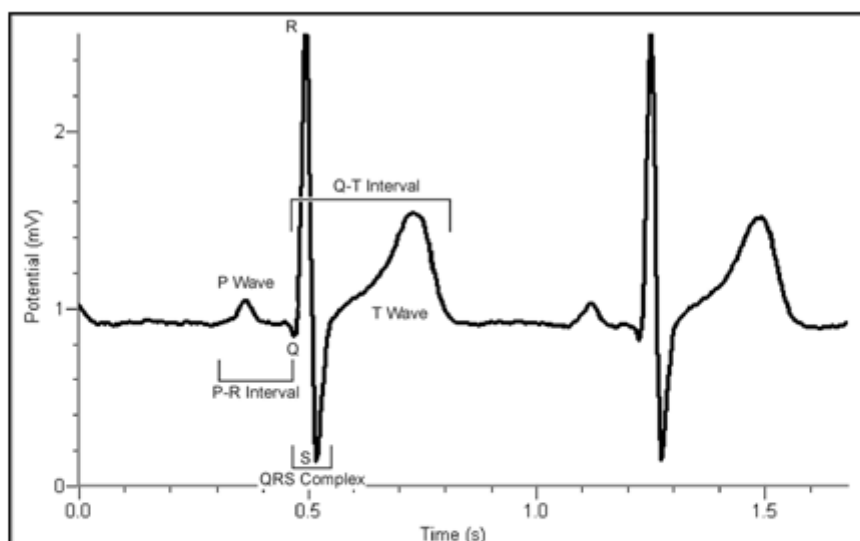
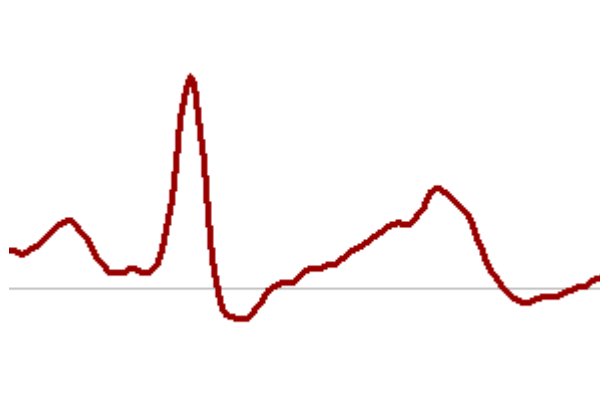


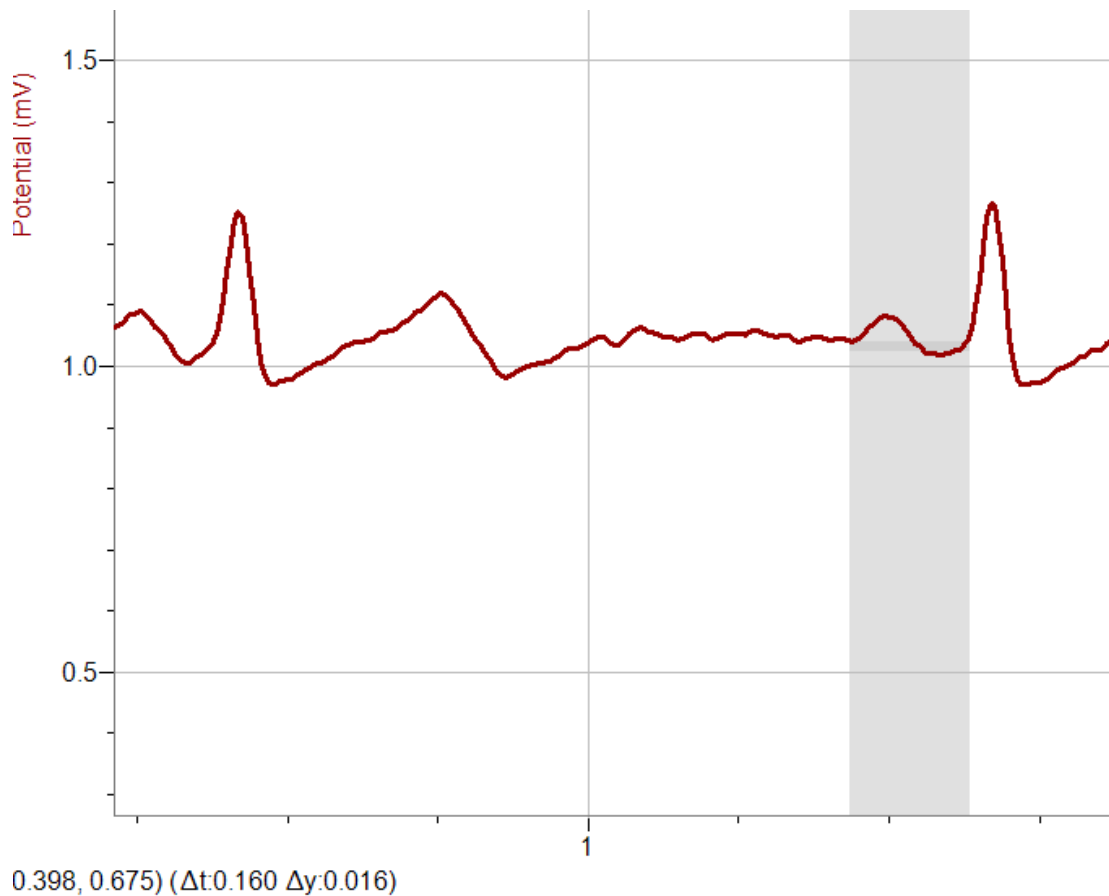
Figure 3

- **P-R interval:** time from the beginning of P wave to the start of the QRS complex
- **QRS complex:** time from Q deflection to S deflection
- **Q-T interval:** time from Q deflection to the end of the T

21. Click the *Zoom In* icon  to zoom in on your data.



22. Click and drag the cursor bar to highlight each interval listed in Table 1. Notice that the time and potential values, which correspond to the cursor bar location, appear at the bottom of the screen (shown as Δt and Δy).



23. Enter the value of each time (Δt) to the nearest 0.01 S for each interval listed in Table 1.
24. Compare your measurements to the normal ranges shown in Table 2 below. Describe any differences in your laboratory journal.

Table 2	
Standard Resting Electrocardiogram Interval Times	
P–R interval	0.12 to 0.20 s
QRS interval	less than 0.12 s
Q–T interval	0.30 to 0.40 s

25. Calculate the heart rate in beats/min using the EKG data and record it to the nearest whole number in Table 1.
26. Copy the analysis graph and paste it into a Word document. Save the document as instructed by your teacher. (Remember, place the mouse cursor over the graph, left click on the graph, press both the *Control* and the *C* keys, and then paste [press both the *Control* and *V* keys] the graph into a new document in Word.)
27. Go to the link: <http://www.nobelprize.org/educational/medicine/ecg/>
28. Click on “Play the ECG Game.”
29. Follow directions in order to diagnose each patient with a particular heart condition based on EKG data. Fill in the table below. (make a copy of the table unto your LB).

