Experiment

28

Monitoring EKG

An electrocardiogram, or EKG, is a graphical recording of the electrical events occurring within the heart. A typical EKG tracing consists of five identifiable deflections. Each deflection is noted by one of the letters P, Q, R, S, or T. The P wave is the first waveform in a tracing and represents the depolarization of the heart's atria. The next waveform is a complex and consists of the Q, R, and S deflection. The QRS complex represents the depolarization of the heart's ventricles. The deflection that represents the repolarization of the atria is usually undetectable because of the intensity of the QRS waveform. The final waveform is the T wave and it represents the repolarization of the ventricles.

Because an EKG is a recording of the heart's electrical events, it is valuable in diagnosing diseases or ailments that damage the conductive abilities of the heart muscle. When cardiac muscle cells are damaged or destroyed, they are no longer able to conduct the electrical impulses that flow through them. This causes the electrical signal to terminate at the damaged tissue or directed away from the signal flow. The termination or redirection of the electrical signal will alter the manner in which the heart contracts. A cardiologist can look at a patient's electrocardiogram and determine the presence of damaged cardiac muscle based on the waveform as well as the time interval between electrical events.

In this activity, you will use the EKG sensor to make a five-second graphical recording of your heart's electrical events. From this recording, you will identify the previously mentioned waveform components and determine the time intervals associated with each.

OBJECTIVES

In this experiment, you will

- Use the EKG Sensor to graph your heart's electrical activity.
- Determine the time interval between EKG events.
- Calculate heart rate based on your EKG recording.

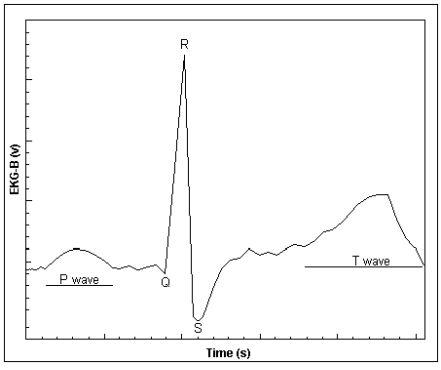


Figure 1

MATERIALS

computer
Vernier computer interface
Logger*Pro*
Vernier EKG Sensor
disposable electrode tabs

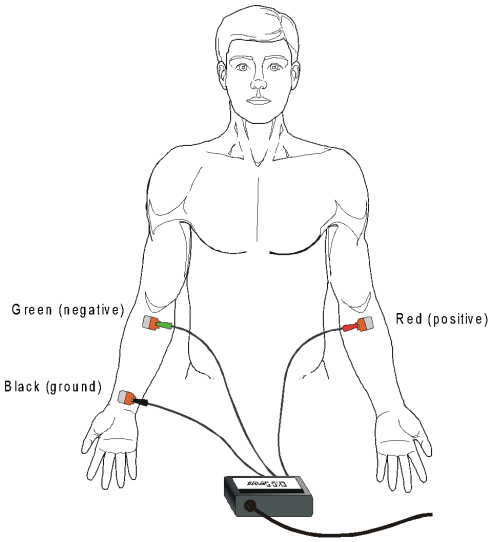


Figure 2

PROCEDURE

1. Connect the EKG Sensor to the Vernier computer interface. Prepare the computer for data collection by opening the "28 Monitoring EKG" file in the *Biology with Computers* folder.

2. Attach three electrode tabs to your arms, as shown in Figure 2. A single patch should be placed on the inside of the right wrist, on the inside of the right upper forearm (below elbow), and on the inside of the left upper forearm (below elbow).

3. Connect the EKG clips to the electrode tabs as shown in Figure 2. Sit in a reclined position in a chair or lay flat on top of a lab table. The arms should be hanging at the side unsupported. When everything is positioned properly, click Collect to begin data collection. If your graph has a stable baseline as shown below, continue to Step 4. If your graph has an unstable baseline, collect a new set of data by clicking Collect. Repeat data collection until your graph has a stable baseline.

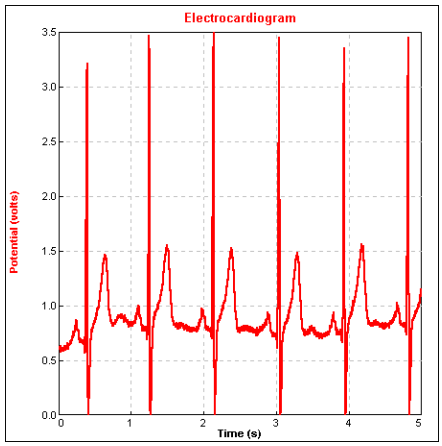


Figure 3: Stable baseline

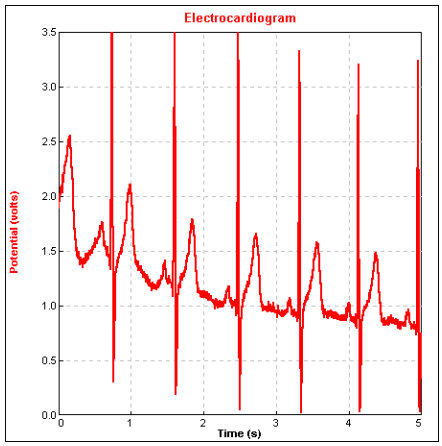
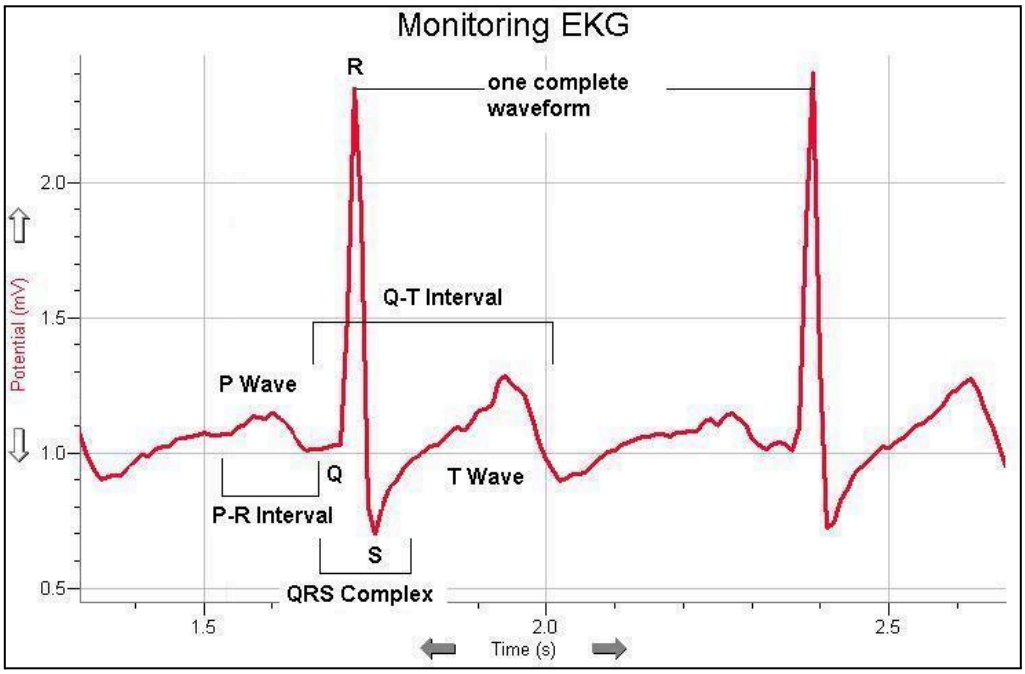


Figure 4: Unstable baseline



4. Click the Examine button, , to analyze the data. As you move the mouse pointer across the screen, the x and y values are displayed in the Examine window that appears. For three heart beats, identify the various EKG waveforms using Figure 5 and determine the time intervals listed below. Record the average for each set of time intervals in Table 1.

   - **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.

5. Calculate the heart rate in beats/min using the EKG data. Remember to include the time between the end of the T Wave and the beginning of the next P Wave. Use the total number of seconds for one full heart cycle in the equation. Record the heart rate in Table 1.

$$\frac{\#\,\text{beats}}{\text{minute}} = \frac{1\,\text{beat}}{__\,\text{seconds}} \times \frac{60\,\text{seconds}}{1\,\text{minute}}$$

6. Print a copy of your EKG. Identify and label the various waveforms.

DATA

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

Heart Rate	_____ beats/min

Table 2	
Standard Resting Electrocardiogram Interval Times	
P - R interval	0.12 to 0.20 s
QRS interval	less than 0.10 s
Q - T interval	0.30 to 0.40 s

QUESTIONS

1. The electrocardiogram is a powerful tool used to diagnose certain types of heart disease. Why is it important to look at the time intervals of the different waveforms?

2. What property of heart muscle must be altered in order for an EKG to detect a problem? Explain.

3. Based on what you have learned regarding electrocardiograms, can they be used to diagnose all heart diseases or defects? Explain.

4. Describe a cardiovascular problem that could be diagnosed by a cardiologist using an electrocardiogram.

EXTENSION

Using data collected with the EKG Sensor, it is possible to determine a more accurate maximum heart rate value for an individual. The commonly used formula for calculating maximum heart rate is:

220 bpm – Individual's Age = Max Heart Rate

While this formula is sufficient for general purposes, it fails to take into account physical differences such as size, and fitness level. For example, an individual that engages in regular exercise will likely have a heart that operates more efficiently due to the effects of athletic training.

To calculate your maximum heart rate, do the following:

a. Run in place or perform some type of exercise, such as jump-n-jacks, for 1-minute.
b. Repeat Steps 1 – 4 to collect and analyze your electrocardiogram. When analyzing the data in Step 4, only determine the average Q-T interval.
c. Divide 60 seconds by the Q-T interval to calculate your maximum heart rate.