Analyzing the Heart with EKG

OBJECTIVES

In this experiment, you will

- Obtain graphical representation of the electrical activity of the heart over a period of time.
- Learn to recognize the different wave forms seen in an EKG, and associate these wave forms with activity of the heart.
- Determine the heart rate by determining the rate of individual wave forms in the EKG.

MATERIALS

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

PROCEDURE

Part I Standard limb lead EKG

1. Connect the EKG Sensor to the Vernier computer interface. Open the file "12 Analyzing Heart EKG" from the *Human Physiology with Vernier* folder.

2. Reset the time parameter to 10 seconds. At the top in the task bar, click Experiment, click Data Collection, and change the duration from 3 seconds to 10 seconds.

2. Attach three electrode tabs to your arms, as shown in Figure 2. Place a single patch on the inside of the right wrist, on the inside of the right upper forearm (distal to the elbow), and on the inside of the left upper forearm (distal to elbow).

3. Connect the EKG clips to the electrode tabs as shown in Figure 2. Sit in a relaxed position in a chair, with your forearms resting on your legs or on the arms of the chair. When you are properly positioned, have someone click ▶ Collect to begin data collection.

4.Once data collection is finished, choose 3 consecutive beats that look similar. Highlight these beats, making sure that you include the tallest peak and the lowest valley within your beats. Next, right click and "Zoom in Graph." You are now ready to collect your data.

5. Click and drag to highlight each interval listed in Table 1. Use Figure 3 as your guide when determining these intervals. Enter the Δt value of each highlighted area to the nearest 0.01 s in Table 1. This value can be found in the **lower left corner** of the graph.

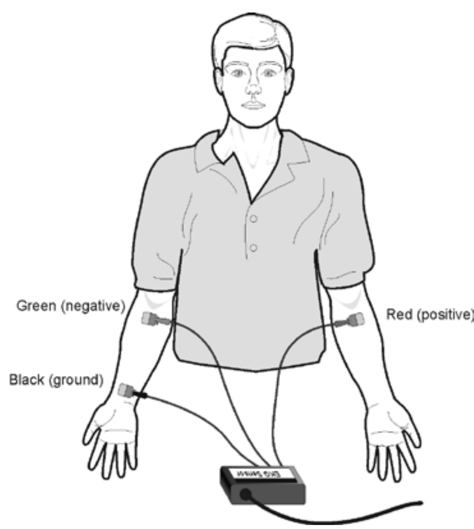


Figure 2

6. Next, obtain the change in potentials (**ΔmV**) for the P-wave, T-wave, and QRS-complex. To find the change in potential for the P-wave, highlight and drag the cursor from the peak of the P-wave to the lowest valley of the P-wave and then click the Statistics button, $\frac{1}{2}$ STAT. From the statistic box, record the maximum and minimum potentials to the nearest 0.01 mV in Table 3. Repeat these steps for determining the change in potential for the QRS-complex and T-wave.

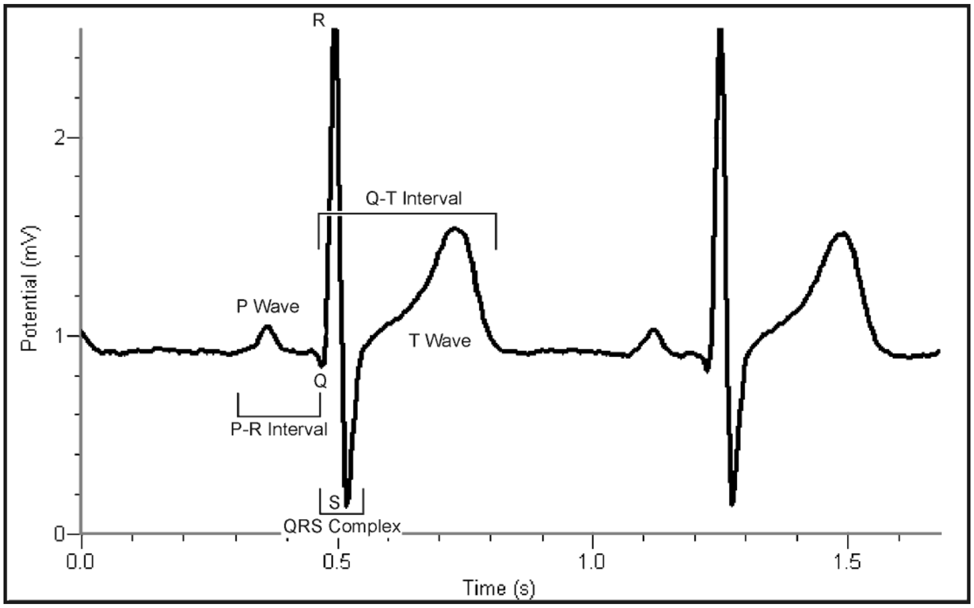


Figure 3

- **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
- **R-R interval:** peak of R1 to peak of R2
- **P-P interval:** peak of P1 to peak of P2
- **T-T interval:** peak of T1 to peak of T2
- **P-T interval:** start of P1 to end of T1

DATA

Table 1- Electrocardiogram Intervals (seconds)	
Interval	Time (s)
P–R	
QRS	
Q–T	
R–R	
P–P	
T–T	
P–T	

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

Table 3- Change in Potential (millivolts)			
	Max (mV)	Min (mV)	∆mV
P- wave			
QRS- complex			
T- wave			

BACKGROUND

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). Even more information is obtained by looking at the story from different angles, which is accomplished by placing electrodes in various positions on the chest and extremities. A positive deflection in an EKG tracing represents electrical activity moving toward the active lead (the green lead in this experiment).

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 looking at several beats you can also calculate the rate for each component.

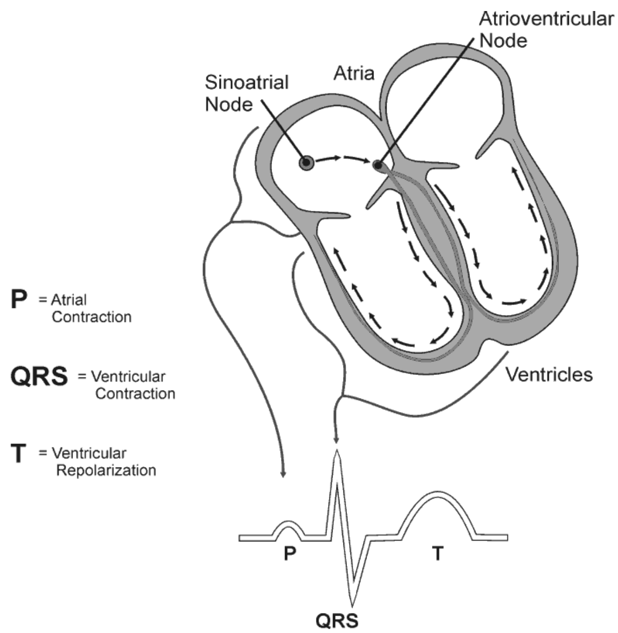


Figure 1

Doctors and other trained personnel can look at an EKG tracing and see evidence for disorders of the heart such as abnormal slowing, speeding, irregular rhythms, injury to muscle tissue (*angina*), and death of muscle tissue (*myocardial infarction*). The length of an interval indicates whether an impulse is following its normal pathway. A long interval reveals that an impulse has been slowed or has taken a longer route. A short interval reflects an impulse which followed a shorter route. If a complex is absent, the electrical impulse did not rise normally, or was blocked at that part of the heart. Lack of normal depolarization of the atria leads to an absent P wave. An absent QRS complex after a normal P wave indicates the electrical impulse was blocked before it reached the ventricles. Abnormally shaped complexes result from abnormal spread of the impulse through the muscle tissue, such as in myocardial infarction where the impulse cannot follow its normal pathway because of tissue death or injury. During a myocardial infarction, death of the myocardium is due to a blockage of a coronary artery, which results in a lack of oxygen reaching the tissue. Electrical patterns may also be changed by metabolic abnormalities and by various medicines.

ANALYSIS QUESTIONS

1. From Table 1, choose any Interval of Time from your graph and Calculate the BPM (beats per minute).

2. How does your QRS interval compare to the Standard Resting Electrocardiogram Interval Times? Citing evidence from the lab's background information, explain what your time indicates?

3. Looking at Table 3, compare the change in potential for the P-wave and the QRS-complex. Which of the 2 has a larger change in potential (**ΔmV**)? Explain anatomically why your choice has the larger change in potential (**ΔmV**).

4. Describe the actions of the heart chambers during the following:

   P-Wave:

   QRS-Complex:

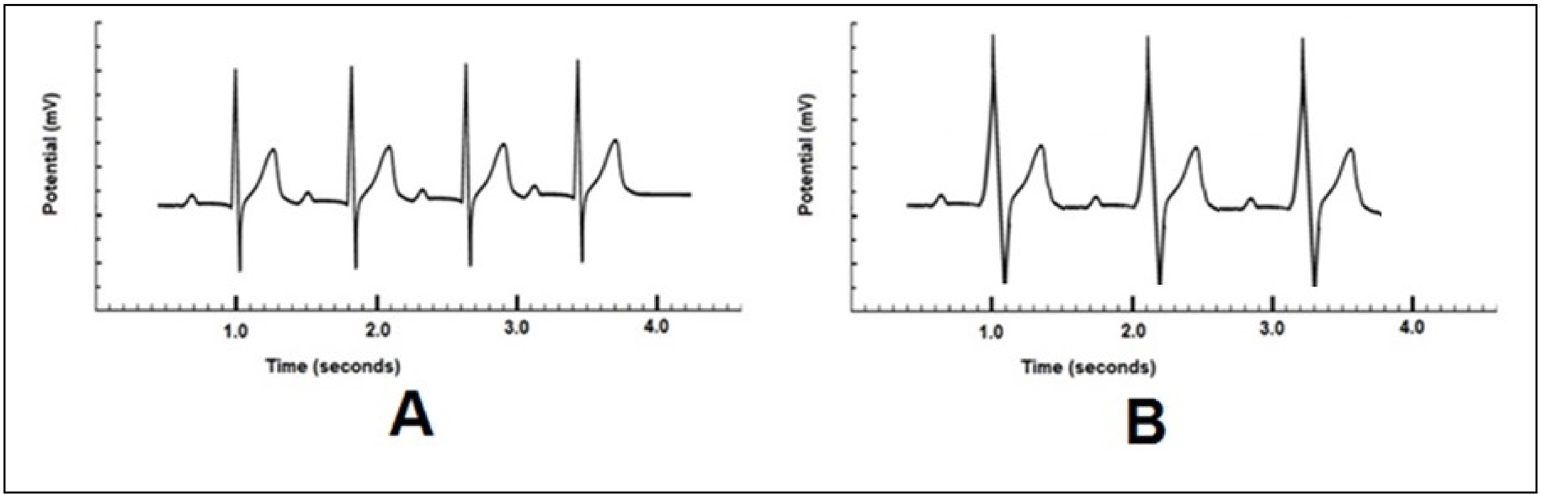
   T-Wave

5. From the sheep heart dissection lab, Question #4, you determined that regurgitation of blood back into the left ventricle, due to a prolapsed aortic semilunar valve, increased the size of the left ventricle. To compensate for the increase in size, due to more blood in the left ventricle, the left ventricle creates more myocardium to generate a larger force of contraction to pump blood.

    a. Describe the electrical activity (mV), increase or decrease, of the left ventricle due to the addition of more myocardium.

    b. How is the time it takes for the left ventricle to contract affected?

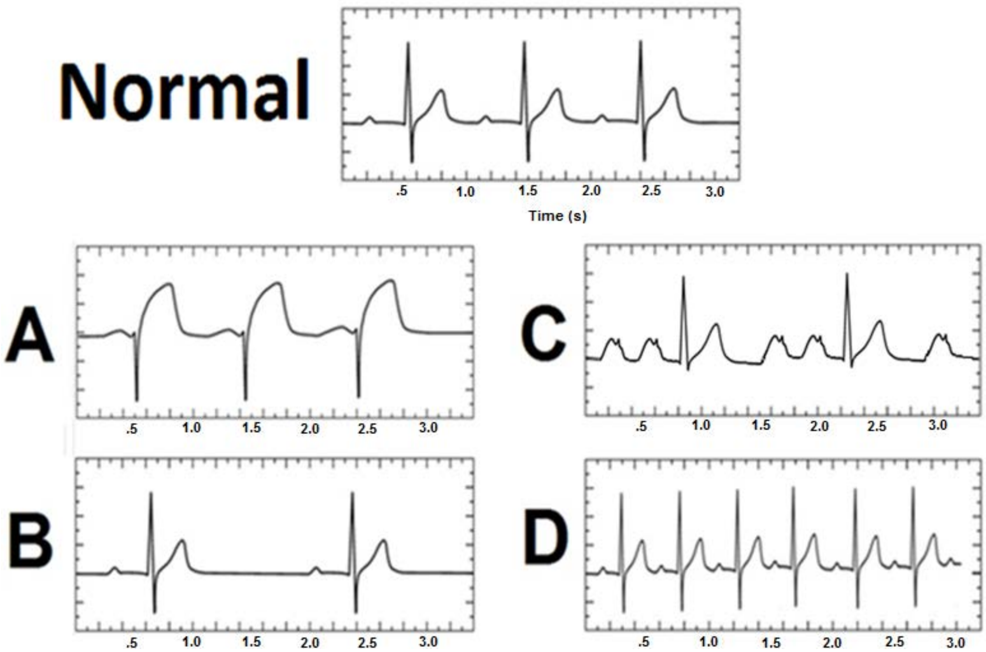
    c. Which graph shows your answers to the above questions? Circle the part of the graph that supports your choice.



Health-care professionals ask the following questions when interpreting an EKG:

- **Can all components be identified in each beat?**
- **Are the intervals between each component and each complex consistent?**
- **Are there clear abnormalities of any of the wave components?**

Using these questions as guides, analyze each of the following EKG tracings and answer the following questions.



6. Examine Graphs A-D. **<u>Which graph shows tachycardia</u>**? Create a claim. Next, provide evidence (graph and calculations) that supports your claim. Finally, provide a reason that links your evidence to your claim. The reason is the "Biology" of the cause of the tachycardia. Provide 2 reasons and the website URL where you obtained your reasons.

Guiding Question: **<u>Which graph shows tachycardia</u>**?	
Claim:	
<u>Evidence #1</u>: (Graph)	Reason: (Research the Biology of the Cause) <u>Reason #1</u> <u>Reason #2</u>
<u>Evidence #2</u>: (Calculations)	Website URL: (Where did you get your reason from?)

7. A Examine Graphs A-D. **Which graph shows bradycardia**? Create a claim. Next, provide evidence (graph and calculations) that supports your claim. Finally, provide a reason that links your evidence to your claim. The reason is the "Biology" of the cause of the tachycardia. Provide 2 reasons and the website URL where you obtained your reasons.

<table>
<tr><td colspan="2">Guiding Question: Which graph shows bradycardia?</td></tr>
<tr><td colspan="2">Claim:</td></tr>
<tr><td>Evidence #1: (Graph)</td><td rowspan="2">Reason: (Research the Biology of the Cause)
Reason #1

Reason #2</td></tr>
<tr><td rowspan="2">Evidence #2: (Calculations)</td></tr>
<tr><td>Website URL: (Where did you get your reason from?)</td></tr>
</table>

8. A man walks in to the emergency room believing he is having a heart attack. As the attending physician, you have determined that the man is indeed having a myocardial infarction (heart attack). **What location (atria or ventricles) of the man's heart is his myocardial infarction occurring**? Create a claim. Next provide evidence by selecting one of the Graphs (A-D) and circling the part of the EKG that supports your claim. Finally, from the background information, provide the reason that links your evidence to your claim.

<table>
<tr><td colspan="2">Guiding Question: What location (atria or ventricles) of the man's heart is his myocardial infarction occurring?</td></tr>
<tr><td colspan="2">Claim:</td></tr>
<tr><td>Evidence: (Graph)</td><td>Reason: (Background)</td></tr>
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