Analyzing the Heart with EKG

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.

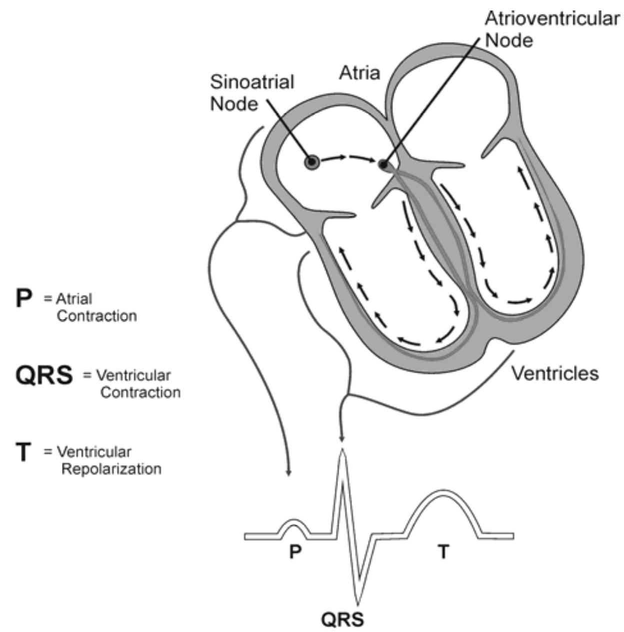

Figure 1

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. Electrical patterns may also be changed by metabolic abnormalities and by various medicines.

In this experiment, you will use the EKG sensor to make a five second graphical recording of your heart’s electrical activity, and then switch the red and green leads to simulate the change in electrical activity that can occur with a myocardial infarction (heart attack). You will identify the different components of the waveforms and use them to determine your heart rate. You will also determine the direction of electrical activity for the QRS complex.

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.
- Compare wave forms generated by alternate EKG lead placements.

MATERIALS

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

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. 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, click and drag to highlight each interval listed in Table 1. Use Figure 3 as your guide when determining these intervals. Enter the Δx 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.
5. Calculate the heart rate in beats/min using the EKG data. Record the heart rate to the nearest whole number in Table 1.
6. Store this run by choosing Store Latest Run from the Experiment menu.

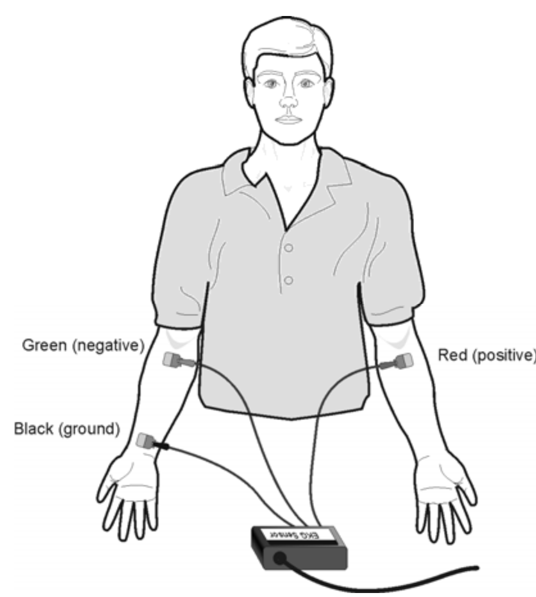

Figure 2

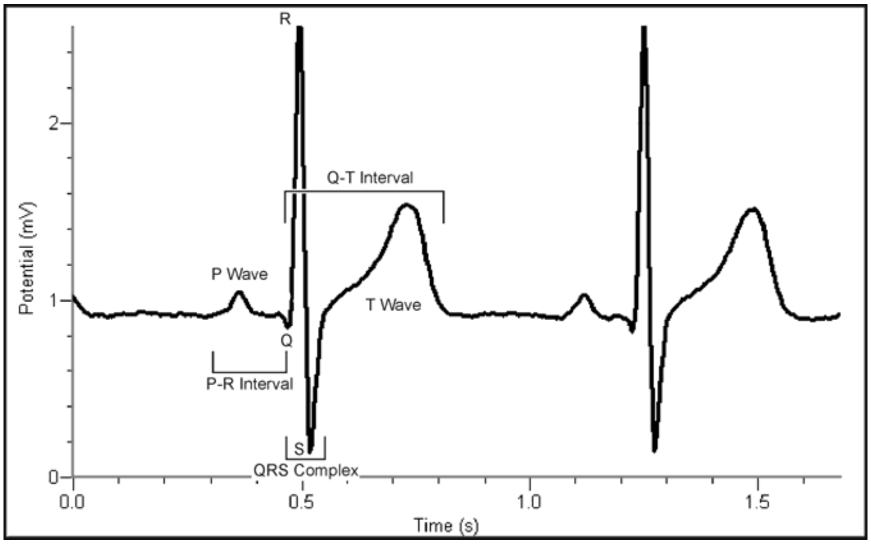

Figure 3

- **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

DATA

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

Heart Rate (bpm)	

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

DATA ANALYSIS

1. Calculate the BPM (beats per minute) using the length of time between R-R.

2. How does your P-R interval compare to the Standard Resting Electrocardiogram Interval Times? QRS interval? Q-T interval?

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

   P-Wave:

   QRS-Complex:

   T-Wave

4. Looking at your graph, what is the maximum potential (mV) of your atrial contraction (P-wave)?

5. Looking at your graph, what is the maximum potential (mV) of your repolarization of your ventricles (T-wave)?

6. Looking at your graph, what is the maximum potential (mV) of your ventricular contraction (QRS complex)?