

EKG: ELECTRICAL WAVES OF THE HEART

How do the PQRST portions of an EKG relate to the physiology of a heartbeat, and how is an EKG used to calculate heart rate?

Objectives

- Explain how EKG periods relate to electrical and muscular activity of the heart.
- Relate heart rate to an EKG.

Materials and Equipment

- Data collection system
- EKG sensor
- Electrode patches (3)
- Soap and water or non-alcohol wipe
- Paper towels
- Conductivity gel (optional)



Safety

Follow these important safety precautions in addition to your regular classroom procedures:

- The electrode patches are intended for use with a single student and cannot be re-used.

Procedure

1. Connect the EKG sensor to your device and choose the *EKG and Heart Rate* file from the **Templates** menu.

*NOTE: If the file is not available, create a two-pane display . Assign a **Graph**  to the large pane and select **Voltage (mV)** for the y-axis measurement. Assign a **Digits** display for the small pane and select the **Heart Rate (Beats/Min)** measurement.*

2. Work in pairs. One student will collect data and keep track of time while the subject or person whose EKG is being measured will stay comfortably seated.
3. The subject must cleanse the inside forearms just below the elbow fold and inside right wrist with a cleansing wipe or soap and water, then dry. The areas to wash are labeled as positions 1, 2, and 3 in Figure 1. Positions 1 and 2 are located on the right arm and position 3 is on the left arm.
4. Grasp electrode patches by their non-adhesive tabs. Firmly place in positions 1, 2, and 3 with tabs towards the insides of the arms as shown.
5. Find the black (R), green (-), and red (+) alligator clips at the end of the three EKG sensor wires. On the right arm, attach the black (R) alligator clip to the tab at position 1 and attach the green (-) alligator clip at position 2. On the left arm, attach the red (+) alligator clip at position 3. Make sure the electrode wires can move freely while the alligator clips are securely attached to each electrode tab.

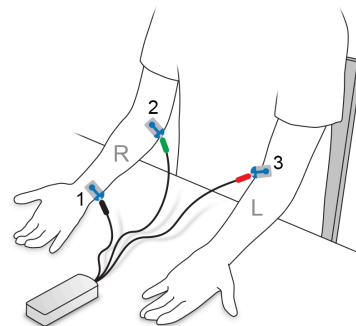






Figure 1. 1 = Black(R); 2 = Green(-); 3 = Red(+)

NOTE: If necessary, move the plastic cover away from each alligator clip tip to maximize clip-tab contact.

6. Have the subject sit quietly in a chair with their legs un-crossed and arms on a table, palms facing up as shown in Figure 1.
7. Remind the test subject to relax, remain still, and to not look at the data as it is recorded.

8. Select **Start** to begin collecting data. Stop collecting data after 20 seconds. Record the heart rate in Table 1.

NOTE: If the EKG does not show distinct waves or heart rate fluctuates by 10 or more beats per minute, apply new electrode patches with conductivity gel or choose a different test subject.

9. Find 5 seconds of data where heartbeats appear consistent. Open the **Graph Tools** menu  and toggle from **Move** mode  to **Select** mode .
10. Draw a box around the 5-second data portion to select it. Scale the selection. .

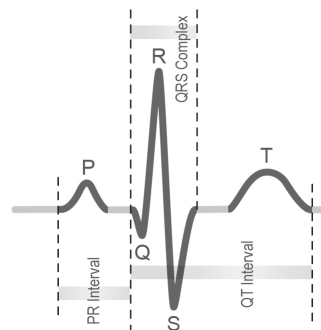




Figure 2. P wave, QRS complex, and T wave

11. Adjust the x-axis scale to view about 3 seconds of data that clearly shows a P wave, QRS complex, and T wave (refer to Figure 2). Sketch your results in Graph 1 and label one set of P, Q, R, S, and T areas. Include numbers, labels, and units on the x- and y-axes.

*NOTE: Turn off data markers to make the waveform fluctuations easier to see. Open **Graph Tools**, choose **Properties** , and set the **Data Point Marker** to **Hidden**.*

12. Refer to Figure 2. Use the Coordinates Tool in SPARKvue  to help you determine the time duration of the QRS complex, the PR interval, and the QT interval (in seconds). Label these areas in Graph 1 and record results in Table 1.

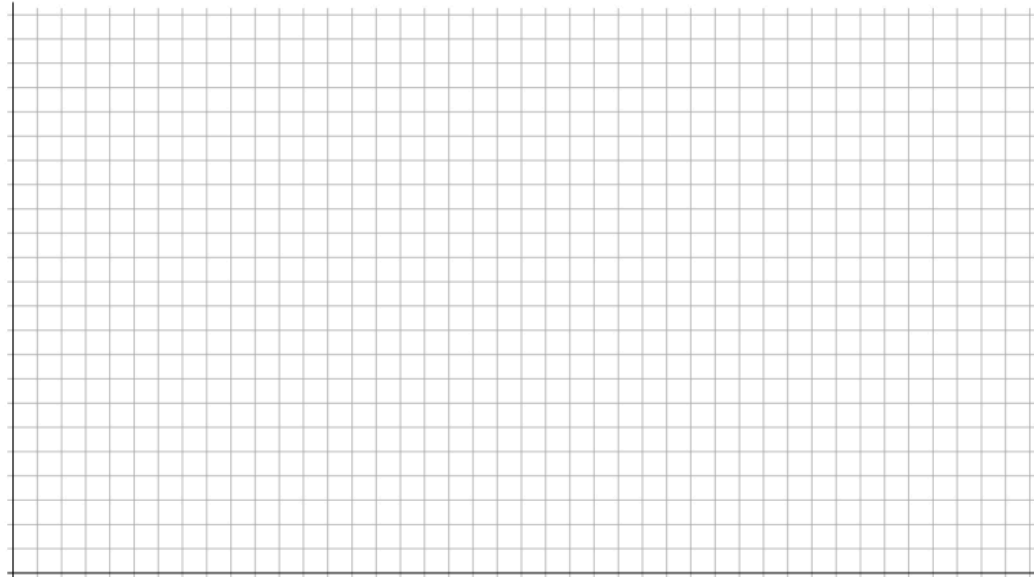
Data Collection

Table 1. Resting EKG Data

Heart Rate (beats/min)	QRS Complex (seconds)	PR Interval (seconds)	QT Interval (seconds)
Typical range, age 12-15*:	0.04 to 0.09	0.09 to 0.18	0.34 to 0.47
Typical range, age 16+*:	0.06 to 0.10	0.12 to 0.20	0.36 to 0.44
*Do not be alarmed if your data falls outside these ranges; healthy hearts often have data outside these ranges. Also, reading an EKG effectively takes considerable training and skill, and the sensor in this activity is not intended for medical purposes.			

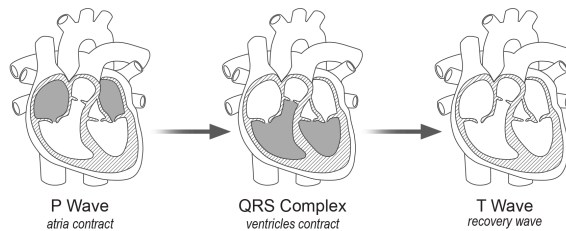
Graph 1:

P wave, QRS complex, and T wave on a resting EKG



Questions and Analysis

1. The heart is a muscular pump made up of four chambers that conduct an electrical current beginning at the SA node, also known as the *pacemaker*. Label the SA node, atria, and ventricles on any one of the following three heart images. The images presented in the anterior or ventral view.



2. The EKG sensor detects the electrical activity within the heart that triggers muscular contraction. Write captions for the three heart images that relate the electrical EKG data with the muscular activity of the heart chambers and movement of blood through the heart.

3. Why is the QRS complex so much larger than the P wave?

4. What does one P to T wave cycle represent, and what does the number of P to T wave cycles per minute represent?

5. Comment on the subject's heart rate reported in Table 1, and predict the effect of exercise on heart rate. Relate your answer to the role of the circulatory system in maintaining homeostasis.

6. Explain how heart cycle timing analysis from an EKG helps doctors diagnose heart problems.