

## Experiment HH-9: ECG and Heart Sounds using an Electronic Stethoscope

### Exercise 1: The ECG and Heart Sounds in a Resting Subject

Aim: To measure the ECG and listen to the heart sounds in a resting individual.

#### Procedure

1. Click on the Record button, located on the upper right side of the LabScribe Main window. The signal should begin scrolling across the screen.

*Note: If the user clicks the Record button and there is no communication between the iWorx unit and computer, an error window will appear in the center of the Main window. Make sure the iWorx unit is turned on and connected to the USB port of the computer. Click OK and select the Find Hardware function from the LabScribe Tools menu.*

2. Click on the AutoScale button at the upper margin of the ECG channel.
  - If the signal on the ECG channel is upside down when compared to trace, click on the downward arrow to the left of the channel title and select the Invert function. The trace should now look similar to the one in the figure
  - If a larger signal is required, the electrodes should be moved from the wrists to the skin just below each clavicle.
3. Press the Power button of the ES-300 electronic stethoscope to power it on. The blue power light should be lit.

*Note: The ES-300 electronic stethoscope automatically shuts off after 2 minutes. Push the Power button to turn the stethoscope back on.*

4. Place the bell of the EM-100 electronic stethoscope on the upper margin of the left side of the chest. See [Figure HH-9-L1](#).
  - Use firm pressure to hold the bell against the skin. Listen for the heart beat.
  - If the “lub dub” sound of the heart beat is not heard clearly, move the stethoscope slightly until you can hear audible heart sounds.
5. Click on the AutoScale button at the upper margin of the Stethoscope channel.
6. When you have a suitable trace, type <Subject’s Name> Resting ECG in the Mark box to the right of the Mark button. Press the Enter key on the keyboard to attach the comment to the data. Record for a minute or two.
7. Click Stop to halt recording.
8. Select Save As in the File menu, type a name for the file. Choose a destination on the computer in which to save the file, like your lab group folder. Designate the file type as \*.iwxdata. Click on the Save button to save the data file.

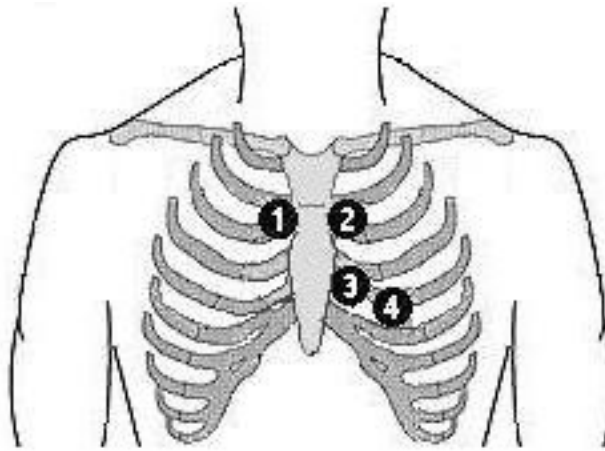


Figure HH-9-1: Auscultation areas on the chest for correct placement of the ES-300 electronic stethoscope: 1-Aortic, 2-Pulmonic, 3-Tricuspid, 4-Mitral.

### Data Analysis

1. Scroll through the recording and find a section of data with four to six good ECG cycles and heart sounds in succession. Use the Display Time icons to adjust the Display Time of the Main window to show at least four complete ECG-heart sounds cycles on the Main window. Four adjacent ECG-heart sounds cycles can also be selected by:
  - Placing the cursors on either side of a group of four complete ECG cycles.
  - Clicking the Zoom between Cursors button on the LabScribe toolbar to expand the segment with the four selected ECG cycles to the width of the Main window. Click on the Analysis window icon in the toolbar ([Figure HH-9-L2](#)) or select Analysis from the Windows menu to transfer the data displayed in the Main window to the Analysis window ([Figure HH-9-L3](#)).

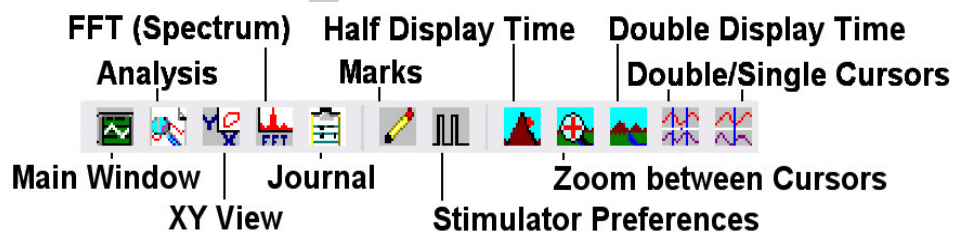


Figure HH-9-L2: The LabScribe toolbar.

2. Look at the Function Table that is above the uppermost channel displayed in the Analysis window. The names of the mathematical functions used in the analysis, V2-V1 and T2-T1, appear in this table. The values for V2-V1 and T2-T1 from each channel are seen in the table across the top margin of each channel.

3. Once the cursors are placed in the correct positions for determining the amplitudes and the beat period on each ECG cycle, the values of these amplitudes and the time interval can be recorded in LabScribe by typing their names and values directly into the Journal, or on a separate data table.
4. The functions in the channel pull-down menus of the Analysis window can also be used to enter the names and values of the parameters from the recording to the Journal. To use these functions:
  - Place the cursors at the locations used to measure the amplitudes and period of the ECG cycle and the heart sounds intervals.
  - Transfer the names of the mathematical functions used to determine the amplitudes and time interval to the Journal using the Add Title to Journal function in the ECG Channel pull-down menu.
  - Transfer the values for the amplitudes and beat period to the Journal using the Add Ch. Data to Journal function in the ECG Channel pull-down menu.
5. Use the mouse to click on and drag the cursors to specific points on the ECG recording ([Figure HH-9-L3](#) and [Figure HH-9-L4](#)) to measure the following:
  - The R-wave amplitude. To measure the R wave amplitude, place one cursor on the Q wave that precedes the R wave and the second cursor on the peak of the R wave. The value for V2-V1 on the ECG channel is this amplitude. Measure the amplitudes of two additional R waves.
  - The P-wave amplitude. To measure the P wave amplitude, place one cursor on the baseline that precedes the P wave and the second cursor on the peak of the P wave. The value for V2-V1 on the ECG channel is this amplitude. Measure the amplitudes of two additional P waves.
  - The T-wave amplitude. To measure the T wave amplitude, place one cursor on the baseline that precedes a P wave and the second cursor on the peak of the T wave that is in the same cycle as that P wave. The value for V2-V1 on the ECG channel is this amplitude. Measure the amplitudes of two additional T waves.
  - The beat period, which is the time interval between two adjacent R waves. To measure the beat period, place one cursor on the peak of a R wave and the second cursor on the peak of the adjacent R wave. The value for T2-T1 on the ECG channel is the beat period. Measure the beat period for two additional pairs of R waves.
  - The R-Lub Interval, which is the time interval between the peak of a R wave and the onset of the first heart sound or “lub” ([Figure HH-9-L4](#)). Record the value for T2-T1 of either channel. Measure this time interval for two additional ECG cycles.
  - The T-Dub Interval, which is the time interval between the peak of a T wave and the onset of the second heart sound or “dub”. Record the value for T2-T1 of either channel. Measure this time interval for two additional ECG cycles.

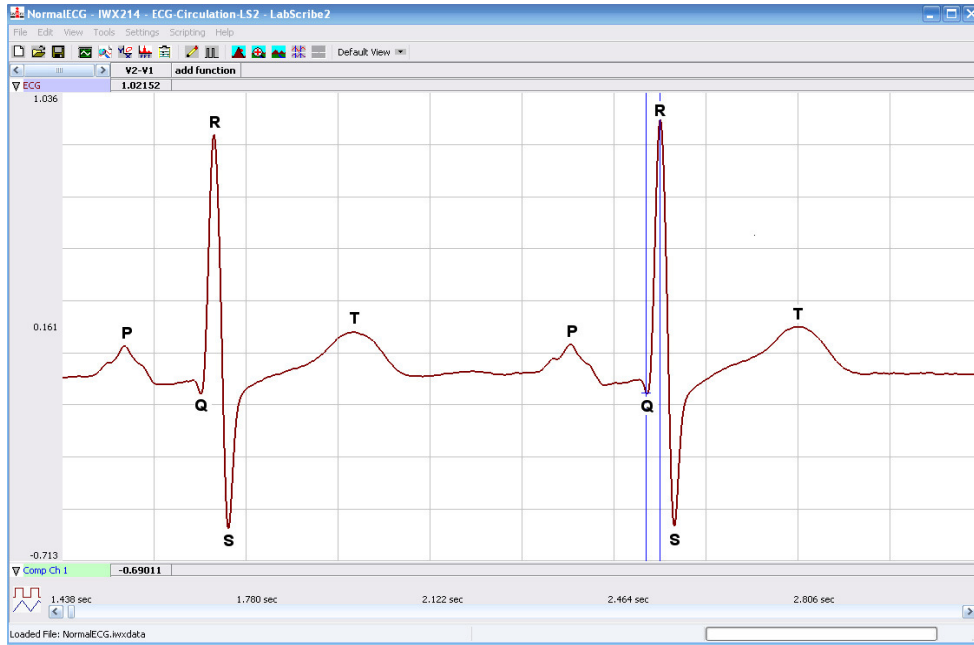


Figure HH-9-L3: ECG recording displayed in the Analysis window. Lines and labels were added to indicate the locations where cursors should be placed to measure the amplitudes of R (Q-R), P (Baseline-P), T (Baseline-T) waves; and, the length of the beat to beat period (R-R).

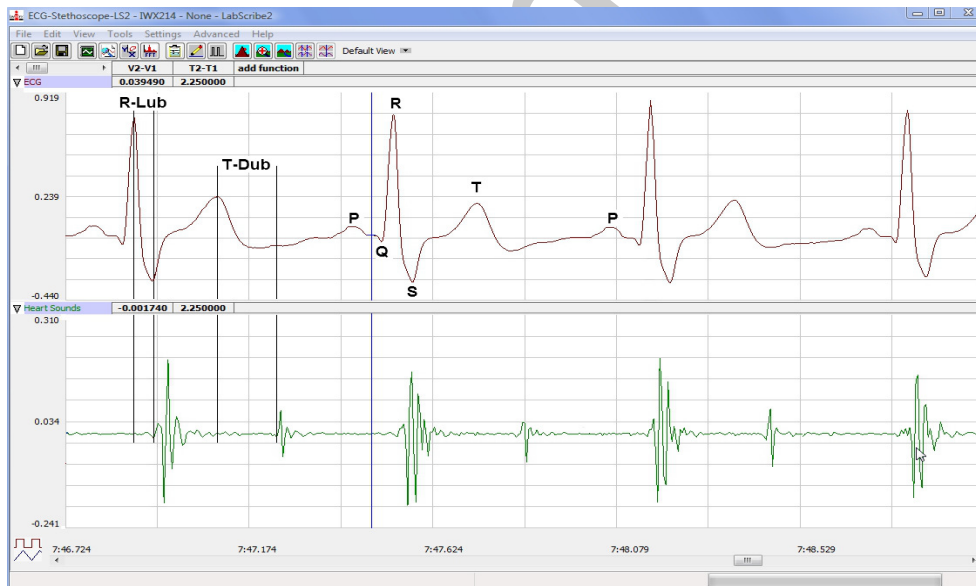


Figure HH-9-L4: ECG and heart sound recording displayed on the Analysis window. Lines and labels were added to indicate the locations where cursors should be placed to measure the R-Lub and T-Dub times.

6. Calculate the following values and type your results into the Journal, or on a separate data sheet:

- The average amplitudes of the P wave, the R wave, and the T wave.
- The average R-Lub interval.
- The average T-Dub interval.
- The average beat period, in seconds/beat.
- The heart rate, which is expressed in beats per minute and calculated from the average beat period by using the following equation:

$$\text{Heart Rate (beats/minute)} = \frac{60 \text{ seconds/minute}}{\# \text{ seconds/beat}}$$

### **Questions**

1. Is the amplitude of each wave (P, QRS, T) always the same in different cardiac cycles?
2. Which wave has the largest amplitude?
3. What is the average resting heart rate of the subject?
4. What is the time difference between the valve closure and the first heart sound? The second heart sound?
5. Why does the lub sound occur around the peak of the R wave?
6. Is the time delay between the R wave and the lub sound always the same? Explain why the time delay is or is not the same.
7. Why does the dub sound occur around the peak of the T wave?
8. Is the time delay between the T wave and the dub sound always the same? Explain why the time delay is or is not the same.

### **Exercise 2: ECG and Heart Sound Recordings from Other Subjects**

Aim: To measure ECG and heart sound parameters from all students.

#### **Procedure**

1. Disconnect the lead wires from the wrists and ankle of the first subject.
2. Place new ECG electrodes on another subject.
3. Turn on the electronic stethoscope if it has powered down.
4. Record the ECG and heart sounds from the second subject, as described in Exercise 1.
5. Repeat this exercise on additional subjects, within the time limits of the lab period. At the beginning of each recording, type the name of the subject on the Marks line and click on the Marks button to identify the recording.

## Data Analysis

Measure the amplitudes of the ECG waves, beat periods, and time of heart sounds of the other subjects using the same techniques used in the analysis section of Exercise 1.

## Questions

1. Do the P waves of different subjects have the same amplitude? The QRS complexes? The T waves? Why?
2. For each subject, determine the wave with the largest amplitude. Is this result the same for all individuals?
3. Is the heart rate the same for each individual?
4. What is the range of resting heart rates within the class?
5. Is the time between valve closure and heart sounds the same for all individuals?
6. Does the heart rate have any correlation to the time of valve closure? Would there be other parameters that may affect the time between valve closure and heart sounds?
7. Are there any obvious correlations between resting heart rate and gender, apparent fitness, or diet of your subjects? To determine apparent fitness, the class may want to compose a list of questions that will allow you to assign a relative fitness factor to each subject.

## Optional Data Analysis

Aim: To analyze the amplitude of the heart sounds.

## Data Analysis

1. Scroll back through the recording to the section of data where the subject was resting. Select an area of data with four to six good ECG cycles and heart sounds in succession.
2. Use the Display Time icons to adjust the Display Time of the Main window to show at least four complete ECG-heart sounds cycles on the Main window. Four adjacent ECG-heart sounds cycles can also be selected by:
  - Placing the cursors on either side of a group of four complete ECG cycles.
  - Clicking the Zoom between Cursors button on the LabScribe toolbar to expand the segment with the four selected ECG cycles to the width of the Main window.
3. Click on the Analysis window icon in the toolbar ([Figure HH-9-L2](#)) or select Analysis from the Windows menu to transfer the data displayed in the Main window to the Analysis window. See [Figure HH-9-L3](#) and [Figure HH-9-L4](#).
4. Look at the Function Table that is above the uppermost channel displayed in the Analysis window. The names of the mathematical functions used in the analysis, V2-V1 and T2-T1, appear in this table. The values for V2-V1 and T2-T1 from each channel are seen in the table across the top margin of each channel.

5. On the Stethoscope channel, place the first cursor on the lowest point of the first heart sound, “lub”. Place the second cursor at the peak of the heart sound. The value V2-V1 measures the amplitude of the sound heard by the closing of the tricuspid and mitral valves.
6. Repeat the previous step using the second, “dub”, heart sound. The value V2-V1 measures the amplitude of the sound heard by the closing of the semilunar valves.
7. Repeat this procedure for 4 consecutive resting heart sounds.
8. Record this data in the Journal or on a separate data table. Calculate the average amplitude for the “lub” sound and for the “dub” sound.
9. Scroll to a section of data after the subject has exercised.
10. Repeat steps 2 through 8 to get the amplitude of both heart sounds in an exercising subject.

### ***Questions***

1. Is the amplitude of the first heart sound the same as the amplitude of the second?
2. What physiological parameter would explain your answer to question 1?
3. Are the amplitudes of the heart sounds of a resting subject higher or lower the amplitudes in an exercising subject?
4. What would account for this difference in amplitudes?