Experiment HS-3: Factors that Affect Breathing Patterns

Exercise 1: Coughing

Aim: To study changes in breathing due to coughing.

Procedure

1. Instruct the subject to:
    - Sit quietly and become accustomed to breathing through the spirometer flowhead.
    - Breathe normally before any recordings are made.
    - Hold the flowhead so that its outlets are pointed up.
    - Remove the flowhead from his or her mouth and hold it at the mouth level in a position that prevents a breath from moving through the flowhead.

Note: *The LabScribe software will zero the Lung Volumes channel during the first ten seconds of recording. No air should be moving through the flow head during this time.*

2. Type <Subject's Name> Sitting in the Mark box that is to the right of the Mark button.
3. Click on the Record button. After waiting ten seconds for the Lung Volumes channel to zero, have the subject place the flowhead in his or her mouth and begin breathing. Press the Enter key on the keyboard to mark the recording.
4. Click the AutoScale buttons of the Air Flow and Lung Volumes channels. Notice the slowly moving wave on the Lung Volumes channel. Record five breaths, which normally takes about forty-five seconds to record.
5. Type Forced in the Mark box. Press the Enter key on the keyboard as the subject inhales as deeply as possible. After reaching his or her maximum inhalation volume, the subject should exhale as quickly and as completely as possible.
6. After the forced exhalation is complete, the subject should continue to breathe through the spirometer.
7. Type Cough in the Mark box. If the subject's breathing has returned to a normal resting pattern, instruct the subject to cough through the flowhead as the Enter key is pressed.
8. Click Stop to halt recording. Your data may look like Figure HS-3-L1.
9. 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.

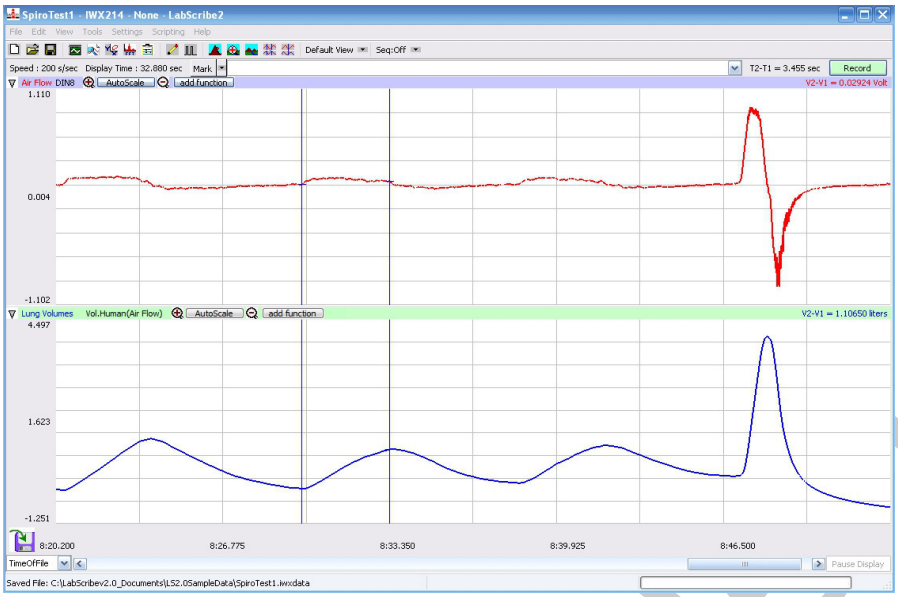

Figure HS-3-L1: Air flow and lung volumes of the normal and forced breathing of a subject at rest.

Data Analysis-Normal Breathing

1. Scroll through the recording and find the section of data recorded when the subject was breathing normally.
2. Use the Display Time icons to adjust the Display Time of the Main window to a couple of normal breath cycles before it on the Main window. This section of data can also be selected by:
    - Placing the cursors on either side of the two normal breath cycles; and
    - Clicking the Zoom between Cursors button on the LabScribe toolbar (Figure 3-L2) to expand the normal breaths to the width of the Main window.

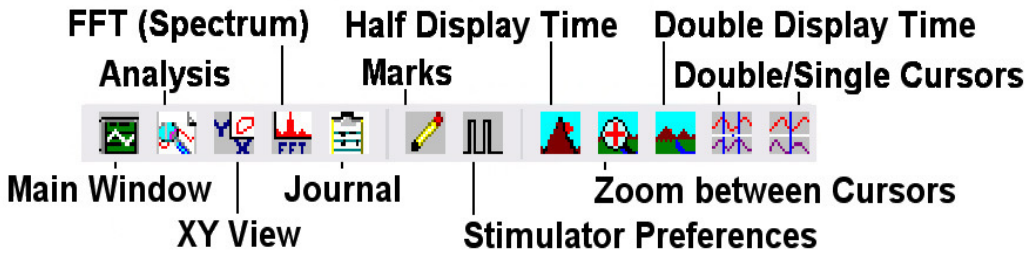

Figure HS-3-4: The LabScribe toolbar.

3. Click on the Analysis window icon in the toolbar or select Analysis from the Windows menu to transfer the data displayed in the Main window to the Analysis window (Figure HS-3-L3).
4. Look at the Function Table that is above the uppermost channel displayed in the Analysis window. The mathematical functions, V2-V1, Max_dv/dt, Min_dv/dt, and T2-T1 should appear in this table. Values for V2-V1, Max_dv/dt, Min_dv/dt, and T2-T1 on each channel are seen in the table across the top margin of each channel.

5. Minimize the height of the Air Flow channel by clicking on the arrow to the left of the channel's title to open the channel menu. Select Minimize from this menu to reduce the height of the channel display.
6. Maximize the height of the trace on the Lung Volumes channel by clicking on the arrow to the left of the channel's title to open the channel menu. Select Scale from the menu and AutoScale from the Scale submenu to increase the height of the data on that channel.
7. Once the cursors are placed in the correct positions for determining the volumes and rates of each breath cycle, the values of the parameters in the Function Table can be recorded in the on-line notebook of LabScribe by typing their names and values directly into the Journal.
8. 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 volumes and rates of the breath cycle.
    - Transfer the names of the math functions used to determine the volumes and rates to the Journal using the Add Title to Journal function in the Lung Volumes Channel pull-down menu.
    - Transfer the values for the volumes and rates to the Journal using the Add Ch. Data to Journal function in the Lung Volumes Channel pull-down menu.
9. On the Lung Volumes channel, use the mouse to click on and drag the cursors to specific points on the recording to measure the following volumes:
    - Tidal Volume (TV), which is the volume of air inhaled or exhaled during a breathing cycle. To measure the tidal volume of the subject during breathing at rest, place one cursor in the trough prior to inhalation, and the second cursor on the peak of the cycle. The value for the V2-V1 function on the Lung Volumes channel is the tidal volume. (Figure HS-3-L3).
    - Maximum Inspiratory Flow Rate, which is the maximum rate of air movement during inhalation. To measure the maximum inspiratory flow rate of the subject during breathing at rest, leave the cursors in the same positions used to measure the tidal volume. The value for the Max_dv/dt function on the Lung Volumes channel is the maximum inspiratory flow rate of that breath cycle.

- Maximum Expiratory Flow Rate, which is the maximum rate of air movement during exhalation. To measure the maximum expiratory flow rate of the subject during breathing at rest, place one cursor on the peak of the breath cycle, and the second cursor in the trough to the right of that peak. The value for the Min_dv/dt function on the Lung Volumes channel is the maximum expiratory flow rate of that breath cycle (Figure HS-3-L4).This function is used since the exhalation portion of the breath cycle has a negative slope.
- Record the values in the Journal using the one of the techniques described in Steps 7 or 8.
- Enter the values for the parameters measured inTable HS-3-L1.

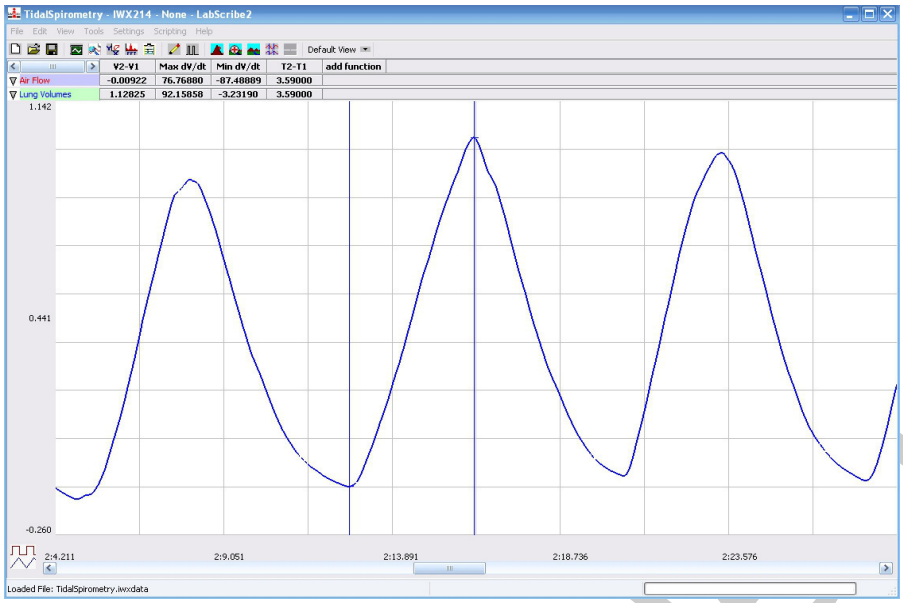

Figure HS-3-L3: Breathing of a sitting subject, displayed on Lung Volumes channel in the Analysis window. The cursors are positioned on the trough and the peak of the breath cycle to measure the tidal volume (TV) with V2-V1 function and the maximum inspiratory flow rate with the Max_dv/dt function.

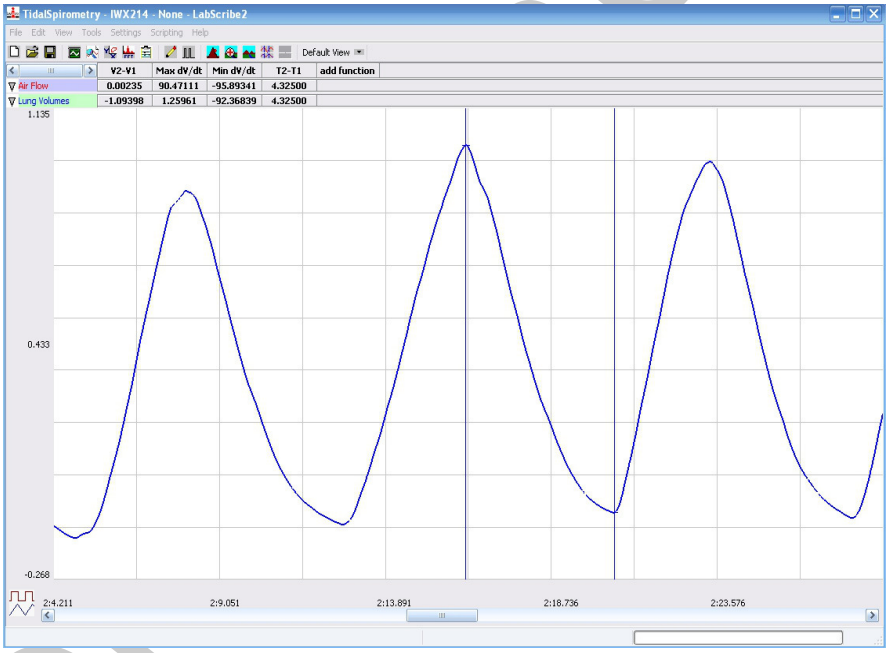

Figure HS-3-L4: Breathing pattern of a sitting subject, displayed on the Lung Volumes channel in the Analysis window. The cursors are positioned on the peak of the breath cycle and the trough of the succeeding cycle to measure the maximum expiratory flow rate with the Min_dv/dt function.

Data Analysis-Forced Breathing

1. Use the slider or the arrows on the scroll bar, at the bottom of the Analysis window, to position the data from the subject's forced breathing in the window.
2. Use the Display Time icons, or the cursors and the Zoom between Cursors button, to adjust the Display Time of the Analysis window to show the complete forced expiration curve in the Main window.

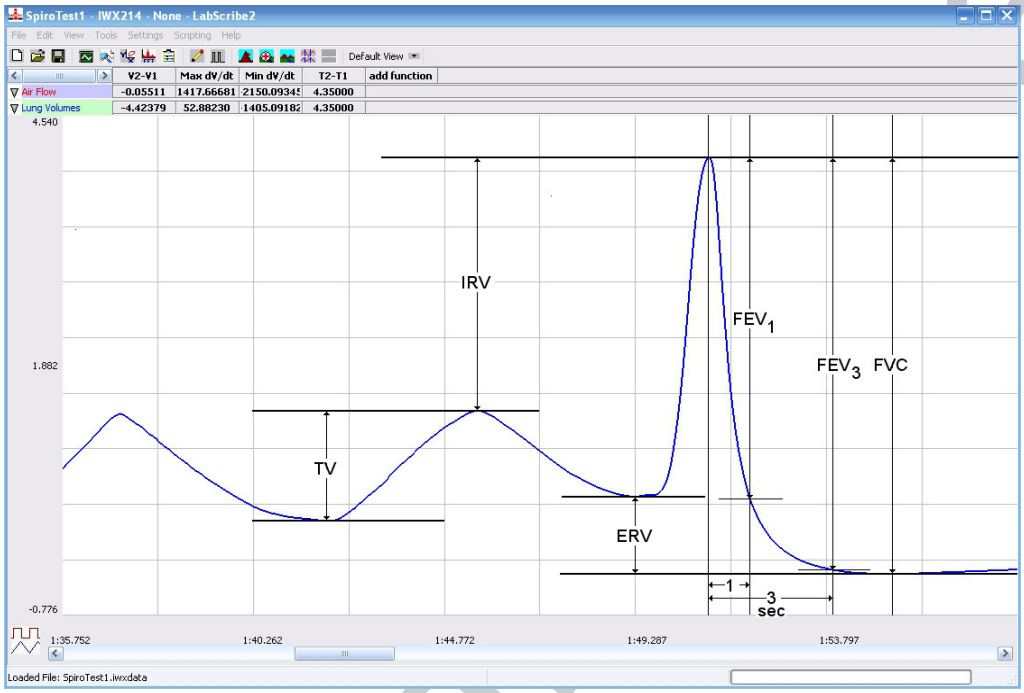

Figure HS-3-L5: Recording of normal and forced lung volumes taken from a subject at rest, and displayed on the Lung Volumes channel in the Analysis window. The normal breathing cycles are to the left of the forced inspiration and expiration. Lines and labels were added to figure to indicate to volumes that should be measured for each subject: Tidal Volume (TV), Inspiratory Reserve Volume (IRV), Expiratory Reserve Volume (ERV), and Vital Capacity.

3. Use the same techniques used earlier to record rates in the Journal.
4. Place the cursors the forced expiration data on the Lung Volumes channel to measure the following volumes and rates using the V2-V1, T2-T1, Max_dv/dt, and Min_dv/dt functions. Check the labels on Figure HS-3-L5 to identify the volumes and rates that you will measure:
    - Forced Inspiratory Flow Rate, by placing one cursor on the peak of the normal breath prior to the maximum inhalation and the second cursor on the peak of the forced breath cycle. The value for the Max_dv/dt function on the Lung Volumes channel is the forced inspiratory flow rate.
    - Forced Vital Capacity (FVC), by placing one cursor on the peak of the forced breath cycle and the second cursor on the flat line after the subject has expelled all the air from his or her lungs. The value for the V2-V1 function on the Lung Volumes channel is the forced vital capacity.

- Forced Expiratory Flow Rate, by keeping the cursors in the same positions used for measuring FVC.The value for the Min_dv/dt function on the Lung Volumes channel is the forced expiratory flow rate.

5. Enter the values for the parameters measured in Table HS-3-L1.

Data Analysis-Coughing

1. Use the slider or the arrows on the scroll bar, at the bottom of the Analysis window, to position the data recorded while the subject coughed in the window.
2. Use the Display Time icons, or the cursors and the Zoom between Cursors button, to adjust the Display Time of the Analysis window to show the complete cough in the Main window.
3. Use the same techniques used earlier to record volumes and rates in the Journal.
4. Place the cursors on the coughing data on the Lung Volumes channel to measure the following parameters using the V2-V1, Max_dv/dt, and Min_dv/dt functions. Measure the following:
    - Maximum Inspiratory Flow Rate before Cough. If the subject inhaled before coughing, determine the maximum flow rate by placing one cursor in the trough or on the baseline prior to the inhalation and the second cursor on the peak of that inhalation. The value for the Max_dv/dt function on the Lung Volumes channel is the maximum flow rate prior to the cough.
    - Maximum Expiratory Flow Rate during Cough. Since a cough is similar to an exhalation, place one cursor on the peak of the inhalation or the baseline before the cough and the second cursor on the trace at the end of the cough. The value for the Min_dv/dt function on the Lung Volumes channel is the maximum flow rate during the cough.
    - Air Expelled during Cough, by keeping the cursors in the same positions used for measuring the maximum exhalatory flow rate.The value for the V2-V1 function on the Lung Volumes channel is the volume of air expelled during the cough.
5. Enter the values for the parameters measured in the data table.

Table HS-3-L1: Breath Rates and Volumes during Normal and Forced Breathing and Coughing

	Normal	Forced	Cough
Tidal Volume			
Forced Vital Capacity			
Air Expelled			
Inspiratory Flow Rate (Maximum or Forced)			
Expiratory Flow Rate (Maximum or Forced)			

Questions

1. What phase of the breathing cycle (exhalation or inhalation) immediately precedes the cough?
2. How does the maximum flow rate during the cough compare to the maximum expiratory flow rate during normal breathing?
3. How does the maximum flow rate during the cough compare to the forced expiratory flow rate during forced breathing?
4. How does the volume of air expelled during a cough compare to the subject's tidal volume and FVC?

Exercise 2: Concentration

Aim: To study any changes in breathing patterns while performing a task.

Procedure

1. Push the tip of a needle firmly into a piece of wax or an eraser. Place the needle close to the subject, on the bench top or the top of the computer monitor.
2. Instruct the subject to:
    - Sit quietly and become accustomed to breathing through the spirometer flowhead.
    - Breathe normally before any recordings are made.
    - Hold the flowhead so that its outlets are pointed up.
    - Remove the flowhead from his or her mouth and hold it at the mouth level in a position that prevents a breath from moving through the flowhead.

Note: *The LabScribe software will zero the Lung Volumes channel during the first ten seconds of recording. No air should be moving through the flow head during this time.*

3. Type <Subject's Name> Before Task in the Mark box that is to the right of the Mark button.
4. Click on the Record button. After waiting ten seconds for the Lung Volumes channel to zero, have the subject place the flowhead in his or her mouth and begin breathing. Press the Enter key on the keyboard to mark the recording.
5. Click the AutoScale buttons of the Air Flow and Lung Volumes channels. Notice the slowly moving wave on the Lung Volumes channel. While recording the subject's normal breathing for about one minute, type Threading Needle in the Mark box.
6. Instruct the subject to thread the needle. Press the Enter key on the keyboard as the subject starts this task. Type Finished in the Mark box.
7. When the subject finishes the task of threading the needle, press the Enter key on the keyboard. Continue to record as the subject's breathing returns to normal. The subject should continue to breathe normally through the spirometer for at least five breath cycles.
8. Click Stop to halt recording.
9. Select Save in the File menu.

Data Analysis-Before the Task

1. Scroll through the recording and find the data collected before the subject threaded the needle.
2. Use the Display Time icons to adjust the Display Time of the Main window to show at least four complete breathing cycles on the Main window. Four adjacent breathing cycles can also be selected by:
    - Placing the cursors on either side of a group of four complete breathing cycles; and
    - Clicking the Zoom between Cursors button on the LabScribe toolbar to expand the four selected breathing cycles to the width of the Main window.
3. Click on the Analysis window icon in the toolbar or select Analysis from the Windows menu to transfer the data displayed in the Main window to the Analysis window.
4. Look at the Function Table that is above the uppermost channel displayed in the Analysis window. The mathematical functions, V2-V1, Max_dv/dt, Min_dv/dt, and T2-T1 should appear in this table. Values for V2-V1, Max_dv/dt, Min_dv/dt, and T2-T1 on each channel are seen in the table across the top margin of each channel.
5. Minimize the height of the Air Flow channel by clicking on the arrow to the left of the channel's title to open the channel menu. Select Minimize from this menu to reduce the height of the channel display.
6. Maximize the height of the trace on the Lung Volumes channel by clicking on the arrow to the left of the channel's title to open the channel menu. Select Scale from the menu and AutoScale from the Scale submenu to increase the height of the data on that channel.
7. Once the cursors are placed in the correct positions for determining the volumes and rates of each breath cycle, transfer the names and values of the parameters measured in the Analysis window to the Journal using one of the two techniques described in Exercises 1.

8. On the Lung Volumes channel, use the mouse to click on and drag the cursors to specific points on the recording to measure the following volumes:

    - Tidal Volume (TV), which is the volume of air inhaled or exhaled during a breathing cycle. To measure the tidal volume of the subject during breathing at rest, place one cursor in the trough prior to inhalation, and the second cursor on the peak of the cycle. The value for the V2-V1 function on the Lung Volumes channel is the tidal volume. (Figure HS-3-L3).
    - Maximum Inspiratory Flow Rate, which is the maximum rate of air movement during inhalation. To measure the maximum inspiratory flow rate of the subject during breathing at rest, leave the cursors in the same positions used to measure the tidal volume. The value for the Max_dv/dt function on the Lung Volumes channel is the maximum inspiratory flow rate of that breath cycle.
    - Maximum Expiratory Flow Rate, which is the maximum rate of air movement during exhalation. To measure the maximum expiratory flow rate of the subject during breathing at rest, place one cursor on the peak of the breath cycle, and the second cursor in the trough to the right of that peak. The value for the Min_dv/dt function on the Lung Volumes channel is the maximum expiratory flow rate of that breath cycle (Figure HS-3-L4).This function is used since the exhalation portion of the breath cycle has a negative slope.
    - Breath Period, which is the duration of each breathing cycle. To measure the breath period of the subject during breathing at rest, place one cursor on a peak of a breath cycle, and the second cursor on the peak of an adjacent cycle. The value for T2-T1 on the Lung Volumes channel is the period of that breath cycle.

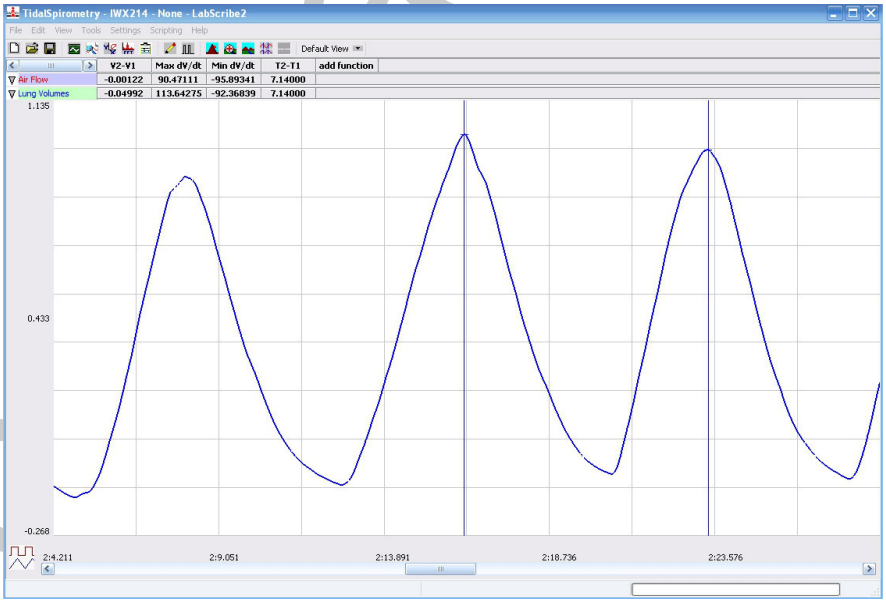

Figure HS-3-L6: Breathing pattern of a sitting subject, displayed on the Lung Volumes channel in the Analysis window. Cursors are positioned on the peaks of breath cycles to measure the breath period with the T2-T1 function.

9. Repeat the measurements of tidal volume, maximum inspiratory flow rate, maximum expiratory flow rate, and breath period on two additional normal breath cycles
10. Average the three values obtained for each parameter and enter the means in a table in the Journal. You can open and close the Journal by clicking on its icon on the LabScribe toolbar.
11. Record the means for the tidal volume, rates, and breath period in Table HS-3-L2.
12. Calculate the normal breathing rate of the sitting subject using the following equation:

$$\text{Breath Rate (breaths/minute)} = \frac{60 \text{ seconds/minute}}{\text{mean breath period (sec/breath)}}$$

13. Multiply the mean tidal volume by the breathing rate to calculate the volume of air passing in and out of the resting subject's lungs each minute.
14. Record the values for these calculations in Table HS-3-L2.

Data Analysis-During Task

1. Scroll through the recording and find the data collected while the subject was threading the needle.
2. Perform the same types of measurements on the data recorded in this section of the exercise as were performed on the data recorded before the subject performed the task. Record the measurements in the Journal. Report the appropriate measurements in Table HS-3-L2.
3. Determine the values for the calculated parameters taken from this section of data. Report these values

Data Analysis-After the Task

1. Scroll through the recording and find the data collected after the subject threaded the needle.
2. Perform the same types of measurements on the data recorded in this section of the exercise as were performed on the data recorded before the subject performed the task. Record the measurements in the Journal. Report the appropriate measurements in the data table.
3. Determine the values for the calculated parameters taken from this section of data. Report these values in the table.

Questions

1. Which breathing parameters changed when fine motor control was required?
2. Explain the reasons why these parameters changed?
3. How long did it take the subject to return to normal breathing after performing the task?

Table HS-3-L2: Breath Volumes and Rates When Completing a Task Requiring Concentration.

	Threading Needle		
	Before	During	After
Mean Breath Period (sec/breath)			
Breathing Rate (breaths/min)			
Mean Tidal Volume (mls/breath)			
Minute Air Flow Rate (liters/min)			
Max Air Flow Rate (mls/sec)			
during inhalation			
during exhalation			

Exercise 3: Sitting Up

Aim: To study any changes in breathing patterns when sitting up.

Procedure

1. Instruct the subject to:
    - Lie down on their back and relax.
    - Become accustomed to breathing through the spirometer flowhead and breathe normally before any recordings are made.
    - Hold the flowhead so that its outlets are pointed up.
2. Assist the subject when he or she is removing and replacing the flowhead in his or her mouth. Place the flowhead on the benchtop near the subject's head in a position that prevents any air to move through the flowhead.

Note: *The LabScribe software will zero the Lung Volumes channel during the first ten seconds of recording. No air should be moving through the flow head during this time.*

3. Type <Subject's Name> Lying Down in the Mark box that is to the right of the Mark button.
4. Click on the Record button. After waiting ten seconds for the Lung Volumes channel to zero, have the subject place the flowhead in his or her mouth and begin breathing. Press the Enter key on the keyboard to mark the recording.

5. Click the AutoScale buttons of the Air Flow and Lung Volumes channels. Notice the slowly moving wave on the Lung Volumes channel. While recording the subject's normal breathing for about one minute, type Sit Up While Inhaling in the Mark box.
6. Press the Enter key on the keyboard as the subject sits up. Type Lying Down in the Mark box.
7. Instruct the subject to lie down. When he or she is lying flat, press the Enter key on the keyboard. Continue to record as the subject's breathing returns to normal. Type Sit Up While Exhaling in the Mark box.
8. After about 60 seconds, instruct the subject to sit up while exhaling normally. Press the Enter key on the keyboard as the subject sits up.
9. Click Stop to halt recording.

Data Analysis

1. Scroll through the recording and find the section of data recorded when the subject was lying down.
2. Use the same techniques used in Exercises 1 and 2 to display a couple of breath cycles on the Main window, and transfer the data to the Analysis window.
3. Once the cursors are placed in the correct positions for determining the volume and rates of each breath cycle, transfer the names and values of the parameters measured in the Analysis window to the Journal using one of the two techniques described in Exercises 1.
4. On the Lung Volumes channel, use the mouse to click on and drag the cursors to specific points on the recording to measure the following volumes:
    - Tidal Volume (TV), which is the volume of air inhaled or exhaled while the subject is breathing normally.
        - To measure the tidal volume from inhalation data, place one cursor in the trough prior to inhalation, and the second cursor on the peak of the inhalation.
        - To measure the tidal volume from exhalation data, place one cursor on the peak of the inhalation, and the second cursor in the trough after the exhalation.
        - The value for the V2-V1 function on the Lung Volumes channel is the tidal volume.(Figure HS-3-L3).
    - Maximum Inspiratory Flow Rate, which is the maximum rate of air movement during inhalation. To measure the maximum inspiratory flow rate of the subject. place one cursor in the trough prior to inhalation, and the second cursor on the peak of the inhalation. The value for the Max_dv/dt function on the Lung Volumes channel is the maximum inspiratory flow rate of that breath cycle.
    - Maximum Expiratory Flow Rate, which is the maximum rate of air movement during exhalation. To measure the maximum expiratory flow rate of the subject, place one cursor on the peak of the inhalation, and the second cursor in the trough to the right of that peak. The value for the Min_dv/dt function on the Lung Volumes channel is the maximum expiratory flow rate of that breath cycle (Figure HS-3-L4). This function is used since exhalation has a negative slope.

5. Record these measurements in Table HS-3-L3.
6. Scroll through the recording and find the section of data recorded when the subject sat up while inhaling. Repeat Steps 2 through 5 on this section of data.
7. Scroll through the recording and find the section of data recorded when the subject sat up while exhaling. Repeat Steps 2 through 5 on this section of data.

Table HS-3-L3: Breath Volumes and Rates When Breathing While Sitting Up.

	Lying Down	Sit Up Inhale	Sit Up Exhale
Tidal Volume (mls/breath)			
Max Air Flow Rate (mls/sec)			
during inhalation			
during exhalation			

Questions

1. Does the maximum inspiratory flow rate while lying down differ from the rate while sitting up while inhaling?
2. Does the maximum expiratory flow rate while lying down differ from the rate while sitting up while exhaling?
3. Does the volume inhaled or exhaled while sitting up differ from the subject's title volume while lying down?

Exercise 4: Increasing the Length of the Airways

Aim: To study any changes in breathing patterns when the subject breathes through a longer airway.

Procedure

1. In this exercise, use a subject whose normal breathing while sitting has already been recorded.
2. Instruct the subject to:
    - Sit quietly and become accustomed to breathing through the spirometer flowhead.
    - Breathe normally before any recordings are made.
    - Remove the flowhead from his or her mouth. Place a 18-24" length of plastic tubing, about the same diameter as the opening of the flowhead, on the end used as the mouthpiece.
    - Hold the flowhead and the tubing at the same level as the subject's mouth, but in a position that prevents the subject's breath to move through the flowhead.

Note: *The LabScribe software will zero the Lung Volumes channel during the first ten seconds of recording. No air should be moving through the flow head during this time.*

3. Type <Subject's Name> Breathing through Tube in the Mark box to the right of the Mark button.
4. Click on the Record button. After waiting ten seconds for the Lung Volumes channel to zero, have the subject place the free end of the tubing in his or her mouth and begin breathing. Press the Enter key on the keyboard to mark the recording.
5. Click the AutoScale buttons of the Air Flow and Lung Volumes channels. Notice the slowly moving wave on the Lung Volumes channel. Record the subject's breathing for about one minute.
6. Click Stop to halt recording. Select Save in the File menu.

Data Analysis

1. Scroll through the recording and find the section of data recorded when the subject was breathing through a longer airway.
2. Use the same techniques used in Exercises 1 and 2 to display a couple of breath cycles on the Main window, and transfer the data to the Analysis window.
3. Once the cursors are placed in the correct positions for determining the volumes and rates of each breath cycle, transfer the names and values of the parameters measured in the Analysis window to the Journal using one of the two techniques described in Exercises 1.
4. On the Lung Volumes channel, use the mouse to click on and drag the cursors to specific points on the recording to measure the following volumes:
    - Tidal Volume (TV), which is the volume of air inhaled or exhaled during a breathing cycle. To measure the tidal volume of the subject during breathing at rest, place one cursor in the trough prior to inhalation, and the second cursor on the peak of the cycle. The value for the V2-V1 function on the Lung Volumes channel is the tidal volume. (Figure HS-3-L3).
    - Maximum Inspiratory Flow Rate, which is the maximum rate of air movement during inhalation. To measure the maximum inspiratory flow rate of the subject during breathing at rest, leave the cursors in the same positions used to measure the tidal volume. The value for the Max_dv/dt function on the Lung Volumes channel is the maximum inspiratory flow rate of that breath cycle.
    - Maximum Expiratory Flow Rate, which is the maximum rate of air movement during exhalation. To measure the maximum expiratory flow rate of the subject during breathing at rest, place one cursor on the peak of the breath cycle, and the second cursor in the trough to the right of that peak. The value for the Min_dv/dt function on the Lung Volumes channel is the maximum expiratory flow rate of that breath cycle (Figure HS-3-L4).This function is used since the exhalation portion of the breath cycle has a negative slope.

- Breath Period, which is the duration of each breathing cycle. To measure the breath period of the subject during breathing at rest, place one cursor on a peak of a breath cycle, and the second cursor on the peak of an adjacent cycle. The value for T2-T1 on the Lung Volumes channel is the period of that breath cycle (Figure HS-3-L6).

5. Repeat the measurements of tidal volume, maximum inspiratory flow rate, maximum expiratory flow rate, and breath period on two additional breath cycles made with the extended airway.
6. Average the three values obtained for each parameter and enter the means in a table in the Journal. You can open and close the Journal by clicking on its icon on the LabScribe toolbar (Figure HS-3-L2).
7. Record the means for the tidal volume, rates, and breath period in Table HS-3-L4.
8. Calculate the breathing rate of the subject, using an extended airway, with the following equation:

   Breath Rate (breaths/minute) = 60 (seconds/minute) / breath period (sec/breath)

9. Multiply the mean tidal volume by the breathing rate to calculate the volume of air passing in and out of the resting subject's lungs each minute.
10. Record the values for these calculations in the table.

Questions

1. Do you think the oxygen requirements of the subject changed dramatically when the tube was attached?
2. Where does gas exchange take place in the lungs?
3. Does gaseous exchange occur across the walls of the airways (trachea, bronchi and bronchioles)?
4. If you increased the volume of the airways to match the resting tidal volume, would fresh air ever reach the alveoli?
5. Why does the tidal volume increase when the subject breathes through a tube?

Exercise 5: Testing Another Factor on Breathing

Choose another factor that might affect breathing and test its effect. Design your own experimental protocol based on one of the exercises presented in this experiment. Some suggestions for factors that might affect breathing include:

- Meditating before recording breathing.
- Sitting in the lotus position for five minutes before recording breathing.
- Listening to different types of music while breathing.
- Being blindfolded, or wearing earplugs, while breathing.

Table HS-3-L4: The Effect of Airway Length on Breathing

	Airway Length	
	Normal	Long
Mean Breath Period (sec/breath)		
Breathing Rate (breaths/min)		
Mean Tidal Volume (mls/breath)		
Minute Air Flow Rate (liters/min)		
Max Air Flow Rate (mls/sec)		
during inhalation		
during exhalation		