Experiment HS-7: Ventilation and Oxygen Saturation Levels, Part 2

This experiment is a continuation of Experiment HS-6: Ventilation and Oxygen Saturation Levels.

Equipment Required

PC or Mac Computer

IXTA, USB cable, IXTA power supply

PPG-320 Pulse Oximeter

RM-204 Respiration monitor

Pulse Oximeter and Respiration Monitor Setup

1. Locate the pulse oximeter and the RM-204 respiration monitor.
2. Plug the PPG-320 into the PT port on the front of the TA.
3. Plug the DIN8 connector of the RM-204 respiration monitor into the Channel A6 input of the IXTA.
4. Wrap the respiration monitor around the subject's chest, just below the pectoral muscles. Make sure it is snug, but not constricting any inhalation or exhalation.
5. Place the pulse sensor on the volar surface (where the fingerprints are located) of the distal segment of the subject's left middle finger or thumb, and wrap the Velcro strap around the end of the finger to attach the unit firmly in place. It is important that the sensor fit snugly, but not be too tight as to cut off circulation.

Figure HS-7-S1: The RM-204 respiration monitor.

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Figure HS-7-S3: The PPG-320 pulse oximeter and a RM-204 respiration monitor connected to the TA unit.

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Experiment HS-7: Ventilation and Oxygen Saturation Levels, Part 2

This experiment is a continuation of Experiment HS-6: Ventilation and Oxygen Saturation Levels.

Exercise 1: Normal Breathing and Oxygen Saturation

Aim: To determine the effect of normal breathing on the oxygen saturation levels of the subject's blood.

Approximate Time: 20 minutes

Procedure

1. Remind the subject to sit quietly before and during the recordings to prevent the creation of motion artifacts, to sit erect, and to breathe normally.
2. Begin the recording when the subject's breathing is regular and predictable.
3. Type **Normal** in the Mark box.
4. Click Record. Click the mark button to mark the recording.
5. Click the AutoScale All button. Record for at least thirty seconds.
6. Click Stop to halt recording.
7. Select Save in the File menu.

Data Analysis

1. Position the data that was recorded while the subject was breathing normally in the Main window. Use the Display Time icons to adjust the Display Time of the Main window to show the complete breath cycles.

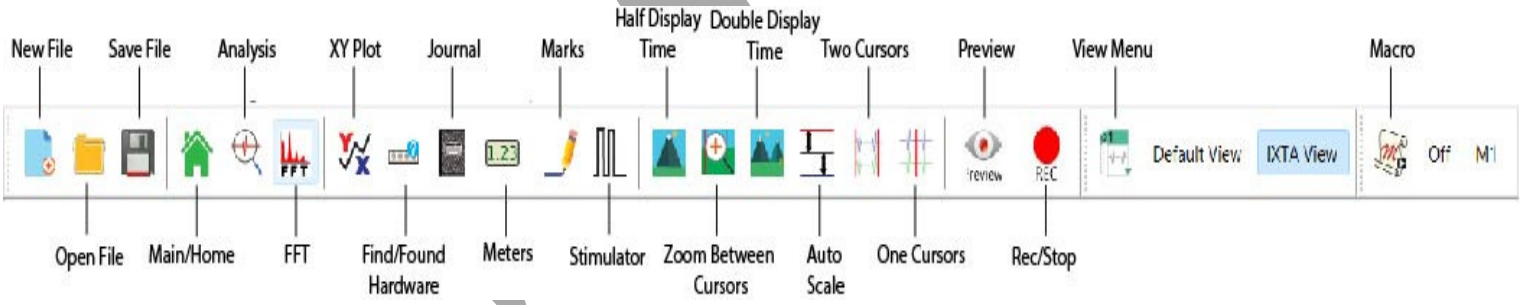

Figure HH-7-L1: The LabScribe toolbar.

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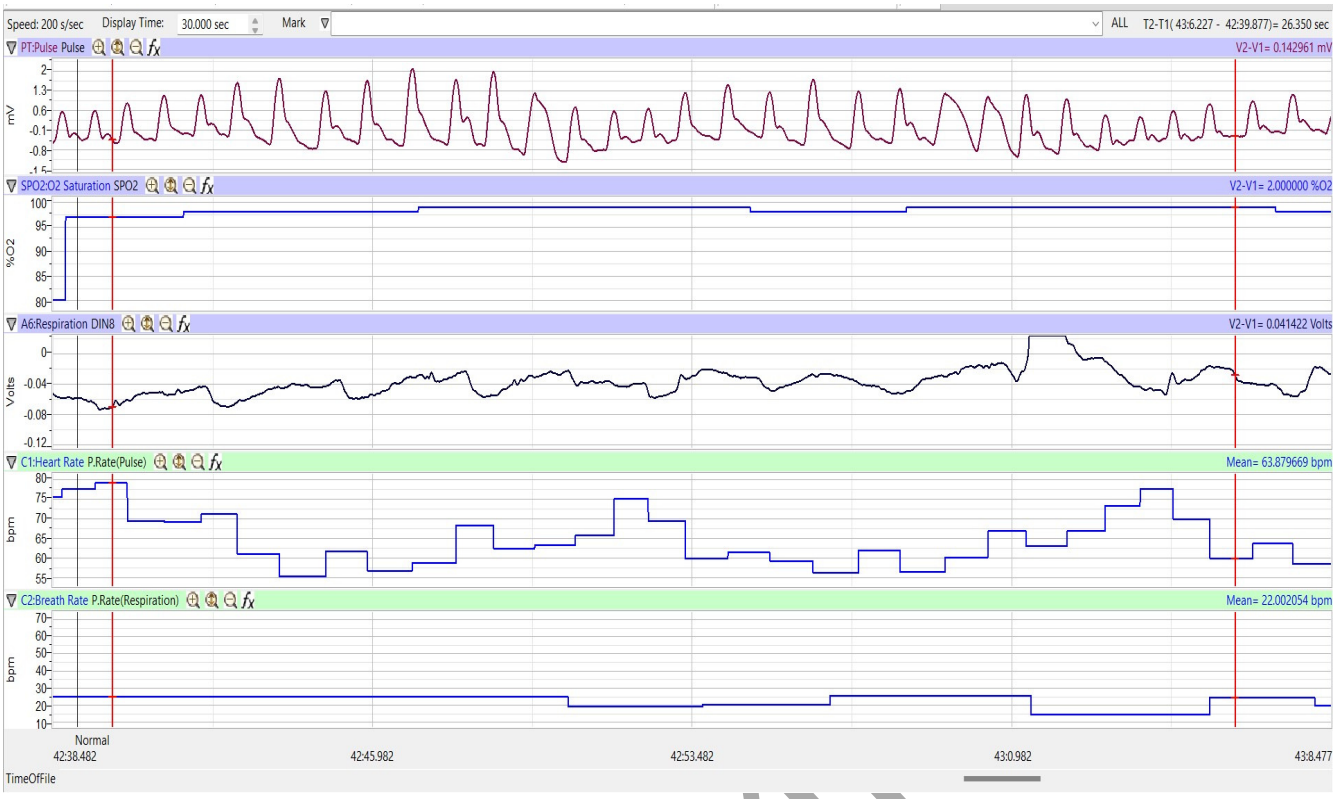

Figure HH-7-L2: Pulse, oxygen saturation, respiration, heart rate, and breath rate during normal abdominal breathing, as displayed on the Main window.

3. Click AutoScale All.
4. Click on the Analysis window icon.
5. Look at the Function Table that is above the uppermost channel displayed in the Analysis window. The mathematical functions, Max, Min, Max-Min, Mean, and T2-T1 should appear on the Functions Table at the top of the Analysis window. Values for Max, Min, Max-Min, Mean, and T2-T1 on each channel are seen in the table across the top margin of each channel.
6. On the Respiration channel, use the mouse to place a cursor at the trough before the beginning of the inhalation of the first breath being measured. Place the second cursor at the trough at the end of the exhalation of the third breath. Measure the following levels and rates.
    - **Maximum Oxygen Saturation Level**, the value for Max on the O2 Saturation channel.
    - **Minimum Oxygen Saturation Level**, the value for Min on the O2 Saturation channel.
    - **Mean Oxygen Saturation Level**, the value for Mean on the O2 Saturation channel.
    - **Change (Δ) in Oxygen Saturation Level**, the value for Max-Min on the O2 Saturation channel.
    - **Maximum Heart Rate**, the value for Max on the Heart Rate channel.
    - **Minimum Heart Rate**, the value for Min on the Heart Rate channel.
    - **Mean Heart Rate**, the value for Mean on the Heart Rate channel.

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- **Change (Δ) in Heart Rate**, the value for Max-Min on the Heart Rate channel.
- **Mean Breath Rate**, the value for Mean on the Breath Rate channel.

7. Once the cursors are placed in the correct positions for determining the saturation levels and heart rate, 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.

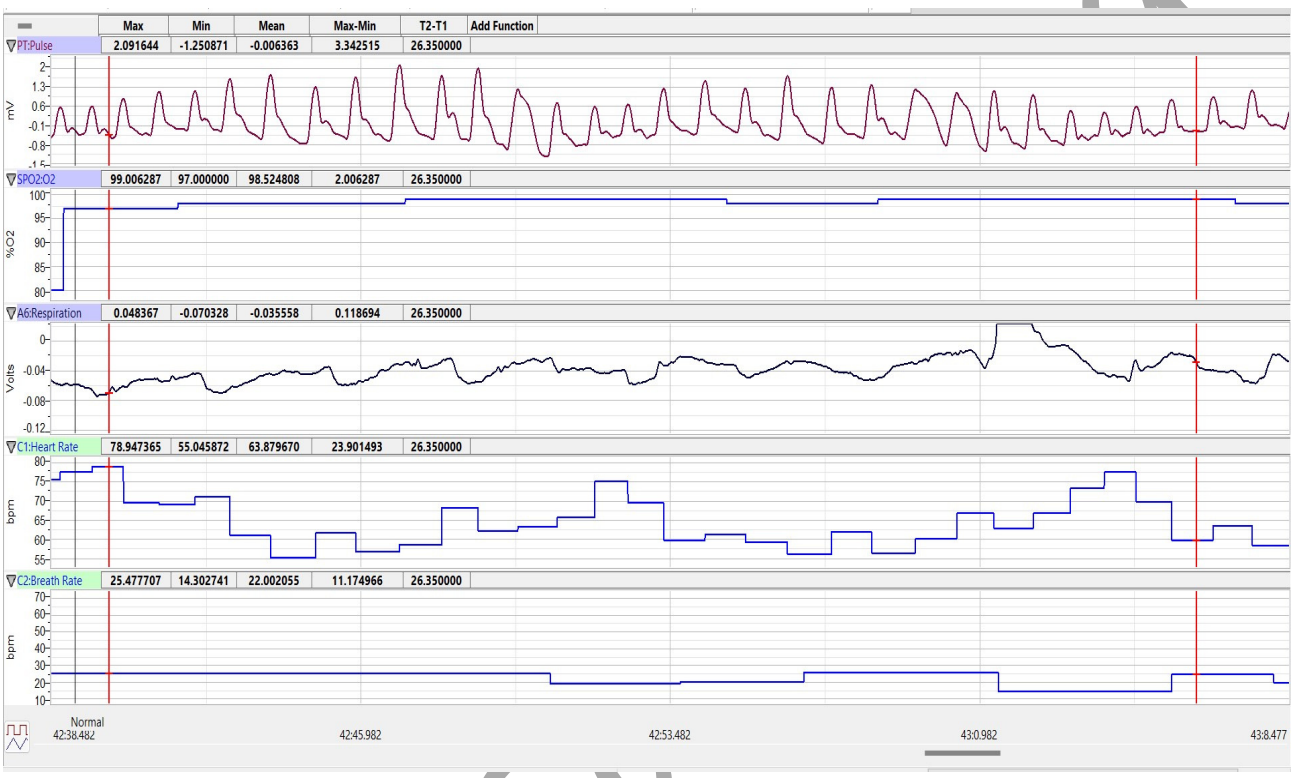

Figure HH-7-L3: Pulse, oxygen saturation, respiration, heart rate, and breath rate during normal abdominal breathing, as displayed on the Analysis window.

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 oxygen saturation levels, heart rate, and breath rate of the selected data.
   - Transfer the names of the mathematical functions used to determine the values to the Journal using the Add Title to Journal function on the pull-down menu of any channel.
9. Record the values in the Journal using the one of the techniques described in Step 8, and in Table 1.
10. Click Save to save the file.

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Exercise 2: Shallow Abdominal Breathing and Oxygen Saturation

Aim: To determine the effect of shallow abdominal breaths on the oxygen saturation levels of the subject's blood.

Approximate Time: 20 minutes

Procedure

1. The subject should sit quietly and breathe normally before the recording begins. Also, remind the subject to sit erect and quietly during the recordings, and to breathe normally at the beginning of the exercise.
2. In this exercise, the subject breathes normally until a regular breathing pattern is established. Then, the subject takes shallow breaths at the rate of 30 to 40 breaths per minute, using the diaphragm as the primary force for moving air in and out of the lungs. The subject should take shallow breaths for 30 to 60 seconds. Finally, the subject returns to breathing normally.
3. Type **Normal** in the Mark box.
4. Click Record. Click the mark button to mark the recording.
5. Click the AutoScale All button. Record until the subject's breathing is regular and predictable.
6. Type **Shallow Abdominal** in the Mark box. Click the mark button as you instruct the subject to start shallow abdominal breathing.
7. Type **Return to Normal** in the Mark box. Click the mark button as the subject exhales and returns to breathing normally. Continue to record until the subject's oxygen saturation level is normal.
8. Click Stop to halt the recording.
9. Click Save to save the file.

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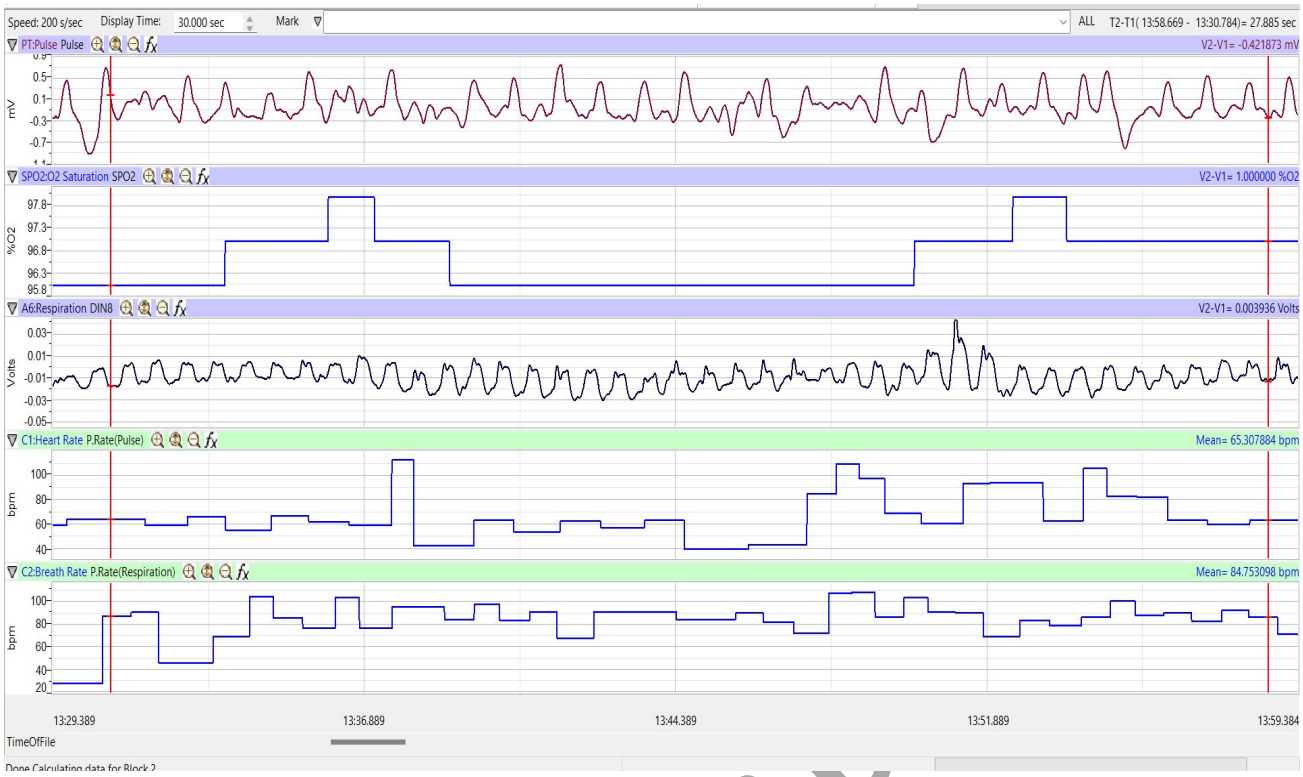

Figure HH-7-L4: Pulse, oxygen saturation, respiration, heart rate and breathing rate during shallow abdominal breathing, as displayed in the Main window.

Data Analysis

1. Position the data that was recorded before, during, and after the subject performed shallow abdominal breathing in the Main window.
2. Use the same technique employed in Exercise 1 to show the period of shallow abdominal breathing and the normal breaths before and after that period on the Main window.
3. Display the data in the Analysis window using the technique used in Exercise 1.

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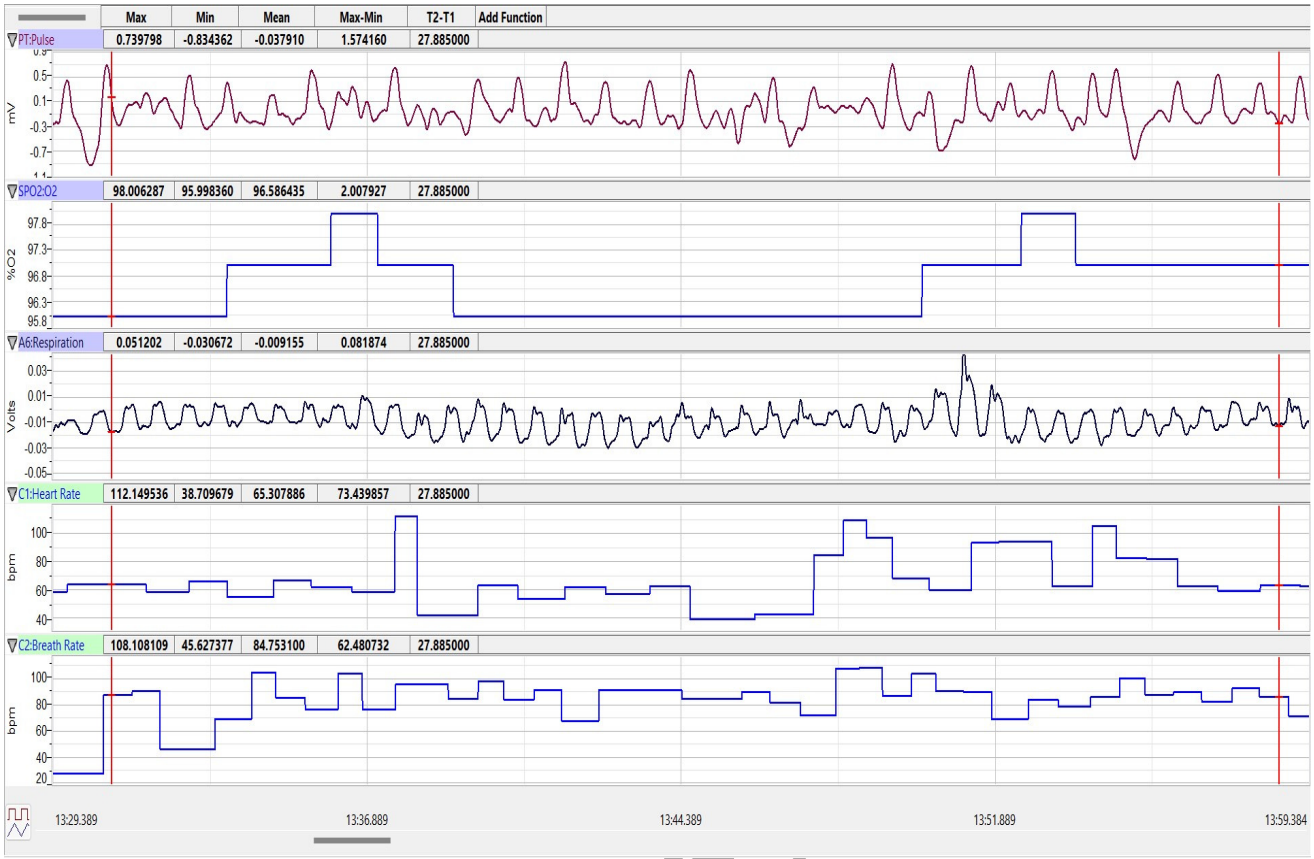

Figure HH-7-L5: Pulse, oxygen saturation, respiration, heart rate, and breathing rate during shallow abdominal breathing, as displayed in the Analysis window. The breathing rate increased from a mean of 22 to a mean of 84 breaths per minute during shallow abdominal breathing. at the same time, the mean oxygen saturation level dropped from 98 to 96%

4. On the Respiration channel, place the cursors at the beginning and end of the shallow abdominal breathing segment. Measure the following levels and rates.
    - **Maximum Oxygen Saturation Level**, the value for Max on the O2 Saturation channel.
    - **Minimum Oxygen Saturation Level**, the value for Min on the O2 Saturation channel.
    - **Mean Oxygen Saturation Level**, the value for Mean on the O2 Saturation channel.
    - **Change (Δ) in Oxygen Saturation Level**, the value for Max-Min on the O2 Saturation channel.
    - **Maximum Heart Rate**, the value for Max on the Heart Rate channel.
    - **Minimum Heart Rate**, the value for Min on the Heart Rate channel.
    - **Mean Heart Rate**, the value for Mean on the Heart Rate channel.
    - **Change (Δ) in Heart Rate**, the value for Max-Min on the Heart Rate channel.
    - **Mean Breath Rate**, the value for Mean on the Breath Rate channel.

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5. Record the values in the Journal using the one of the techniques described in Exercise 1, and in Table 1.
6. Move the first cursor from the beginning of the shallow abdominal breathing period to the point in the recovery period where the oxygen saturation level returned to normal.
7. Repeat Steps 5 and 6 for the data collected during the recovery period.
8. Measure the following parameters and record their values in the Journal:
    - **Response Time to Shallow Abdominal Breathing.** Place one cursor at the beginning of shallow abdominal breathing, and the second cursor at the first change in the oxygen saturation level during shallow abdominal breathing. The value for the T2-T1 function is this response time. Record the values in the Journal.
    - **Response Time to Decrease in Oxygen Saturation Level**. Place one cursor at the beginning of shallow abdominal breathing, and the second cursor at the lowest oxygen saturation level. The value for the T2-T1 function is this response time. Record the values in the Journal.
    - **Recovery Time to Normal Oxygen Saturation Level.** Place one cursor at the end of shallow abdominal breathing, and the second cursor at the return of the oxygen saturation level to normal. The value for the T2-T1 function is this response time. Record the values in the Journal.
9. Click Save to save the file.

Questions

1. How does the oxygen saturation level at the end of shallow abdominal breathing compare to the oxygen saturation level during normal breathing?
2. How do the response time to shallow abdominal breathing, response time to the lowest oxygen saturation levels, and recovery time to normal oxygen saturation level compare?
3. How does the heart rate during normal breathing compare to the heart rate at the end of shallow abdominal breathing?
4. Ask the subject to describe how they felt while performing shallow abdominal breathing? Dizzy, faint, flush?

Exercise 3: Bellows Breathing and Oxygen Saturation

Aim: To determine the effect of very rapid breathing, often referred as the Bellows Breathing Technique, on the oxygen saturation levels of the subject's blood.

Approximate Time: 20 minutes

Procedure

1. The subject should sit quietly and breathe normally before the recording begins. Also, remind the subject to sit erect and quietly during the recordings, and to breathe normally at the beginning of the exercise.

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2. In this exercise, the subject breathes normally until a regular breathing pattern is established. Then, the subject breathes as rapidly as possible for as long as possible, moving air in and out through the nose while the mouth is gently closed. Bellows breathing can be as rapid as 2 to 3 breaths per second and **can lead to dizziness**. Finally, the subject returns to breathing normally.
3. Type **Normal** in the Mark box.
4. Click Record. Click the mark button. Click the AutoScale All button. Record until the subject's breathing is regular and predictable.
5. Type **Bellows** in the Mark box. Click the mark button as you instruct the subject to start bellows breathing.
6. Type **Recovery** in the Mark box. Click the mark button as the subject exhales and returns to breathing normally. Continue to record until the subject's oxygen saturation level is normal.
7. Click Stop to halt the recording.
8. Click Save to save the file.

Data Analysis

1. Position the data that was recorded before, during, and after the subject performed bellows breathing in the Main window.

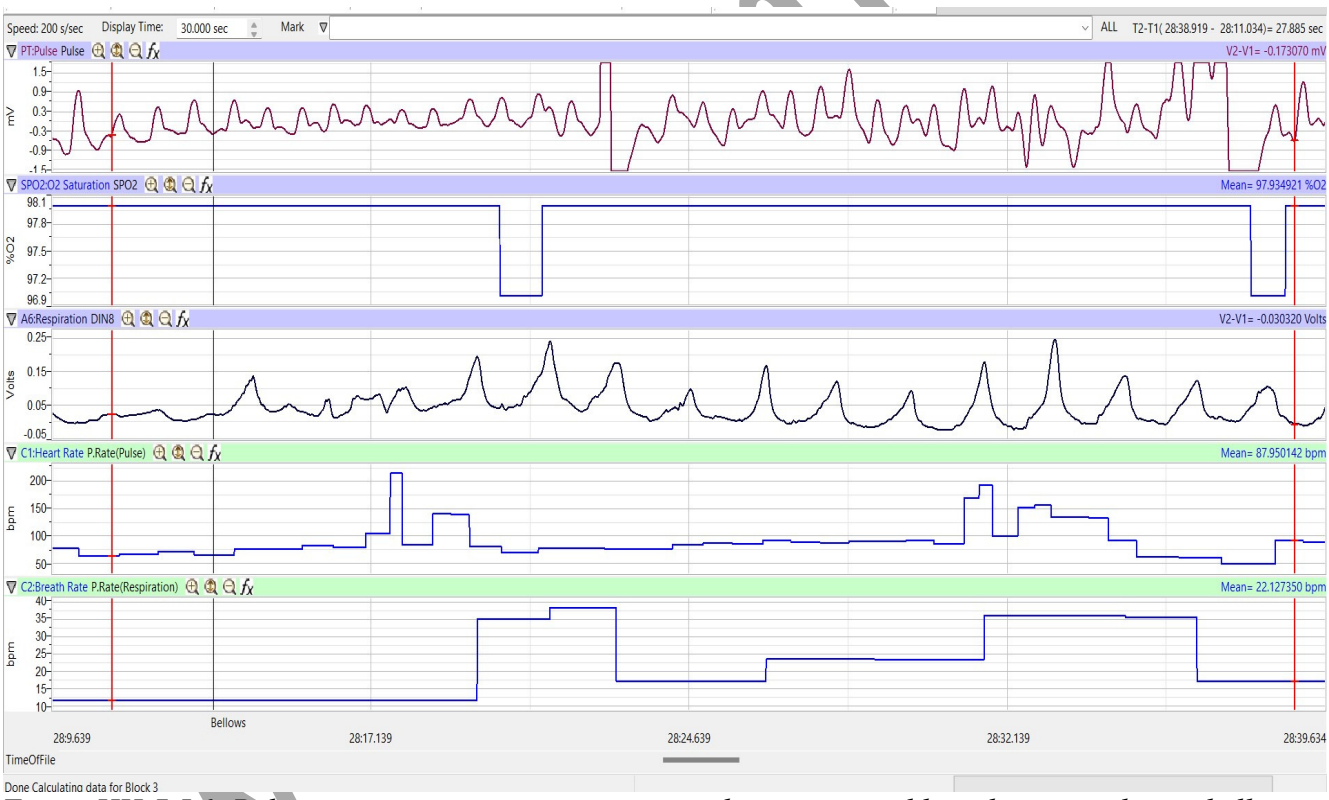

Figure HH-7-L6: Pulse, oxygen saturation, respiration, heart rate, and breathing rate during bellows breathing, as displayed in the Main window.

Workable Lab

2. Use the same technique employed in Exercise 2 to show the period of bellows breathing and the normal breaths before and after that period on the Main window.
3. Display the data in the Analysis window using the technique used in Exercises 1 and 2.

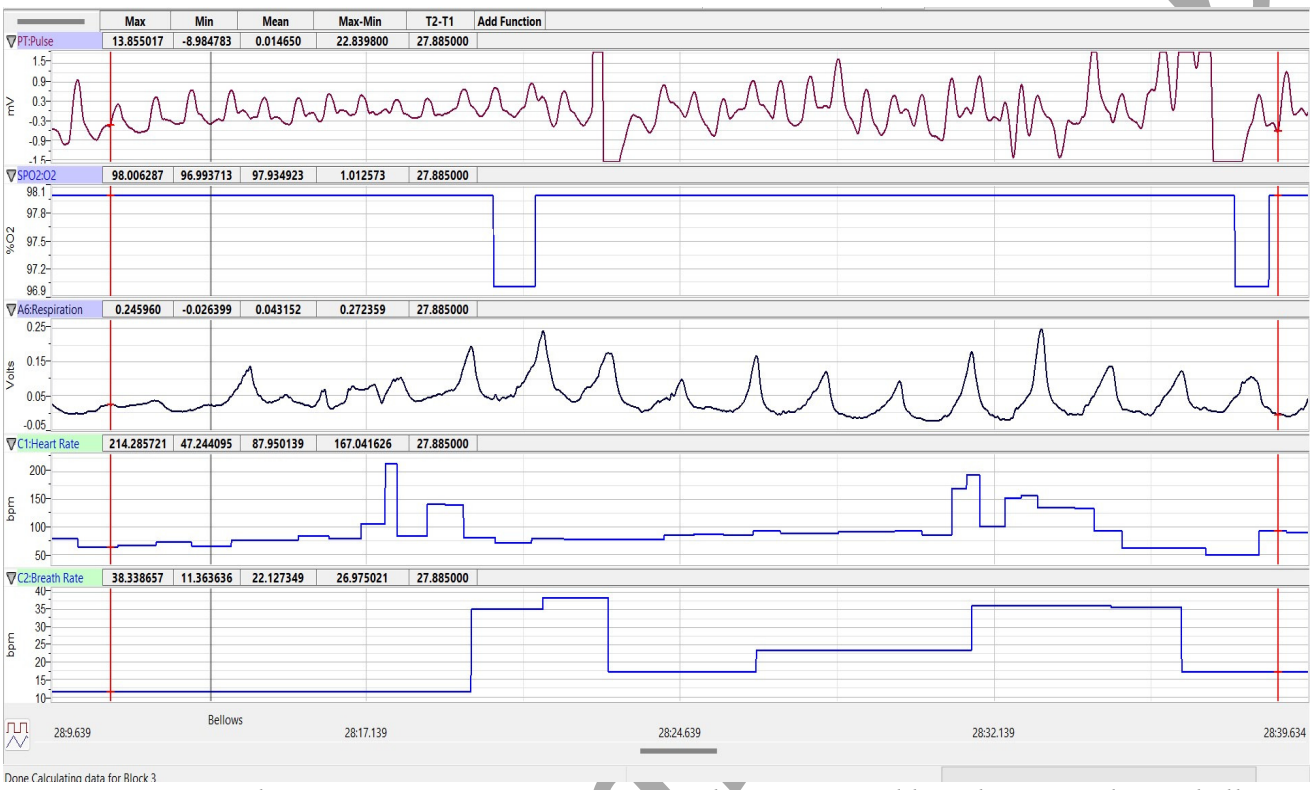

Figure HH-7-L7: Pulse, oxygen saturation, respiration, heart rate, and breathing rate during bellows breathing, as displayed in the Analysis window. In this exercise, the breathing rate increased from a mean of 11 to a mean of 38 breaths per minute during bellows breathing. at the same time, the oxygen saturation level increased from a mean of 97% to a mean of 98%.

4. On the Respiration channel, place the cursors at the beginning and end of the bellows breathing segment. Measure the same parameters as in the previous exercises.
5. Record the values in the Journal using the one of the techniques described in Exercise 1, and in Table 1.
6. Move the first cursor from the beginning of the bellows breathing period to the point in the recovery period where the oxygen saturation level returned to normal.
7. Repeat Steps 4 and 5 for the data collected during the recovery period.
8. Measure the following parameters and record their values in the Journal:
    - **Response Time to Bellows Breathing**. Place one cursor at the beginning of bellows breathing, and the second cursor at the first change in the oxygen saturation level during bellows breathing. The value for the T2-T1 function is this response time. Record the values in the Journal.

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- **Response Time to Decrease in Oxygen Saturation Level**. Place one cursor at the beginning of bellows breathing, and the second cursor at the lowest oxygen saturation level. The value for the T2-T1 function is this response time. Record the values in the Journal.
- **Recovery Time to Normal Oxygen Saturation Level**. Place one cursor at the end of bellows breathing, and the second cursor at the return of the oxygen saturation level to normal. The value for the T2-T1 function is this response time. Record the values in the Journal.

9. Click Save to save the file.

Questions

1. How does the oxygen saturation level at the end of bellows breathing compare to the oxygen saturation level during normal breathing?
2. How do the response time to bellow breathing, response time to the lowest oxygen saturation levels, and recovery time to normal oxygen saturation level compare?
3. How does the heart rate during normal breathing compare to the heart rate at the end of bellows breathing?
4. Ask the subject to describe how they felt while performing bellows breathing?

Exercise 4: Deep Abdominal Breathing and Oxygen Saturation

Aim: To determine the effect of deep abdominal breathing on the oxygen saturation levels of the subject's blood.

Approximate Time: 20 minutes

Procedure

1. The subject should sit quietly and breathe normally before the recording begins. Also, remind the subject to sit erect and quietly during the recordings, and to breathe normally at the beginning of the exercise.
2. In this exercise, the subject breathes normally until a regular breathing pattern is established. Then, the subject breathes slowly and deeply, inhaling through the nose and exhaling through the mouth for 1 minute. Finally, the subject returns to breathing normally.
3. Type **Normal** in the Mark box. Click Record. Click the mark button.
4. Click the AutoScale All button. Record until the subject's breathing is regular and predictable.
5. Type **Deep Abdominal** in the Mark box. Click the mark button as you instruct the subject to start deep abdominal breathing for one minute.
6. Type **Recovery** in the Mark box. Click the mark button as the subject exhales and returns to breathing normally. Continue to record until the subject's oxygen saturation level is normal.
7. Click Stop to halt the recording.

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8. Click Save to save the file.

Data Analysis

1. Position the data that was recorded before, during, and after the subject performed deep abdominal breathing in the Main window.

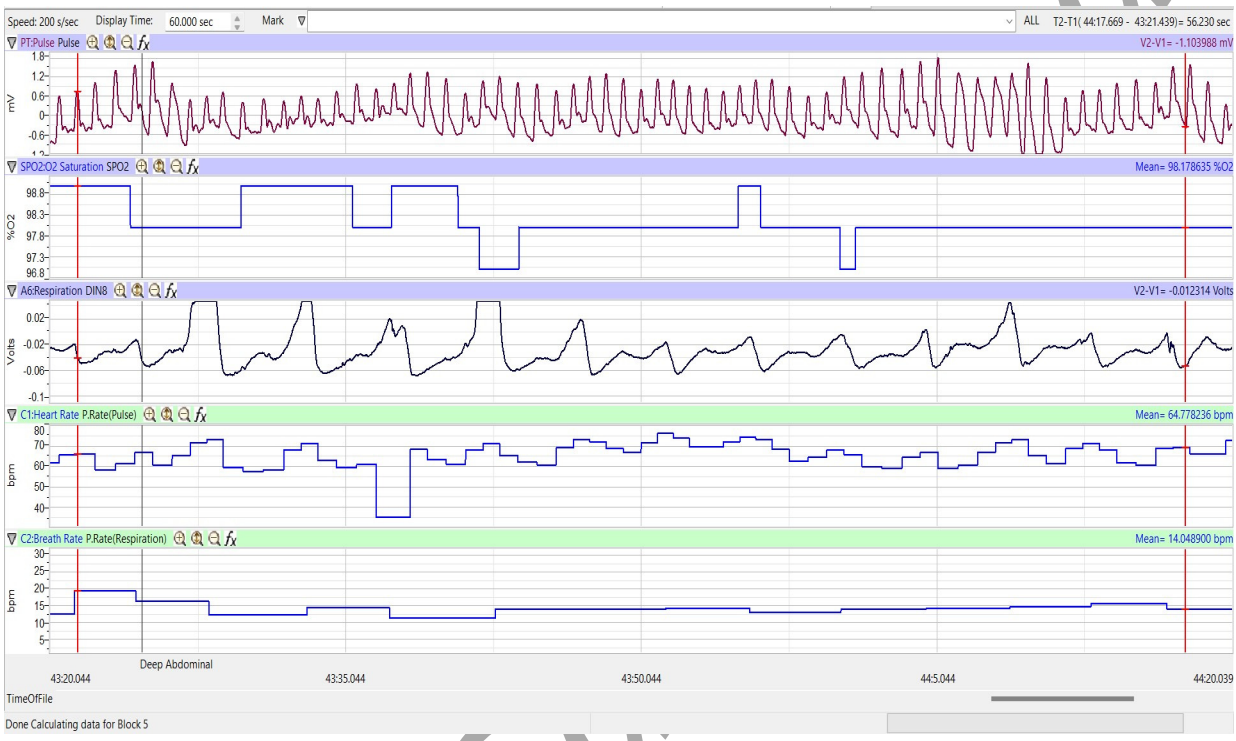

Figure HH-7-L8: Pulse, oxygen saturation, respiration, heart rate and breathing rate during deep abdominal breathing, as displayed in the Main window.

2. Use the same technique to adjust the display time used in Exercises 2 and 3 to show the period of deep abdominal breathing and the normal breaths before and after that period on the Main window.
3. Measure the same values are for the previous exercises.
4. Display the data in the Analysis window using the technique used in Exercises 1, 2, and 3.
5. Record the values in the Journal using the one of the techniques described in Exercise 1, and in Table 1.
6. Move the first cursor from the beginning of the deep abdominal breathing period to the point in the recovery period where the oxygen saturation level returned to normal.
7. Repeat Steps 4 and 5 for the data collected during the recovery period.

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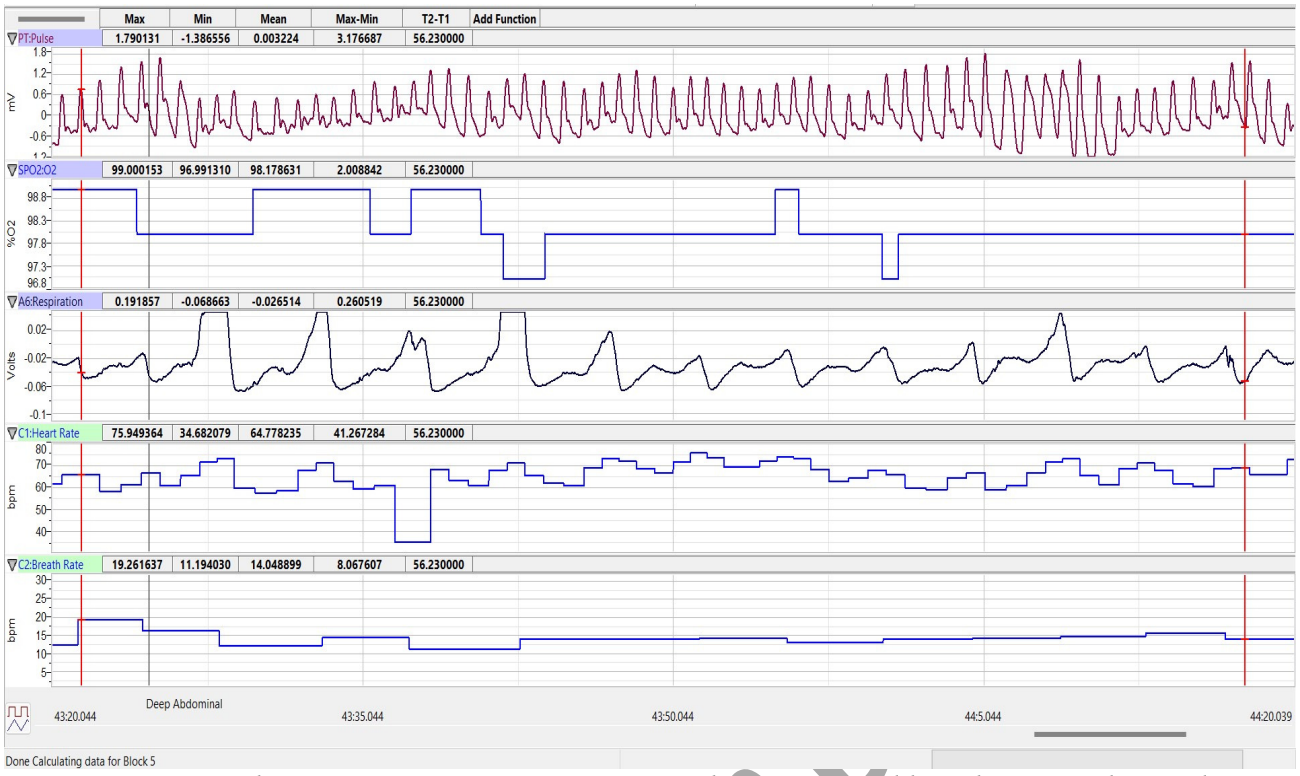

Figure HH-7-L9: Pulse, oxygen saturation, respiration, heart rate, and breathing rate during deep abdominal breathing, as displayed in the Analysis window. In this exercise, the breathing rate decreased from 19 to 14 breaths per minute during deep abdominal breathing. at the same time, the oxygen saturation level increased from a mean of 98% to a mean of 99% before the end of the deep abdominal breathing segment.

5. Measure the following parameters and record their values in the Journal:
    - **Response Time to deep abdominal Breathing**. Place one cursor at the beginning of deep abdominal breathing, and the second cursor at the first change in the oxygen saturation level during deep abdominal breathing. The value for the T2-T1 function is this response time. Record the values in the Journal.
    - **Response Time to Decrease in Oxygen Saturation Level**. Place one cursor at the beginning of deep abdominal breathing, and the second cursor at the lowest oxygen saturation level. The value for the T2-T1 function is this response time. Record the values in the Journal.
    - **Recovery Time to Normal Oxygen Saturation Level.** Place one cursor at the end of deep abdominal breathing, and the second cursor at the return of the oxygen saturation level to normal. The value for the T2-T1 function is this response time. Record the values in the Journal.
9. Click Save to save the file.

Work Sample

Questions

1. How does the oxygen saturation level at the end of deep abdominal breathing compare to the oxygen saturation level during normal breathing?
2. How do the response time to deep abdominal breathing, response time to the lowest oxygen saturation levels, and recovery time to normal oxygen saturation level compare?
3. How does the heart rate during normal breathing compare to the heart rate at the end of deep abdominal breathing?
4. Ask the subject to describe how they felt while performing deep abdominal breathing?
5. How do the oxygen saturation levels during the four breathing techniques studied in this experiment compare?

Table HS-7-L1: Oxygen Saturation Levels, Heart Rates, and Breathing Rates during Various Breathing Techniques and Recovery Periods.

Breathing Pattern	% O2 Saturation				Heart Rate (BPM)				Breath Rate (bpm)
	Max	Min	Mean	Δ	Max	Min	Mean	Δ	Mean
Normal									
Shallow Abdominal									
Recovery - Shallow Abdominal									
Bellows Breathing									
Recovery - Bellows Breathing									
Deep Abdominal									
Recovery - Deep Abdominal									

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