# Experiment HS-9: PulseOx Challenge

## Equipment Required

PC or Mac Computer

IXTA, USB cable, IXTA power supply

SP-304 Spirometer

A-FH-300L Spirometer flow head and plastic tubes

A-SRK Student Respiratory kit

PPG-320 Pulse Oximeter

## Pulse Oximeter and Spirometer Setup

1. Locate the 300L flow head, the airflow tubing, and pulse oximeter and its cables.

*Figure HS-9-S1: The student respiratory kit and FH-300 flow head and the airflow tubing. The blue filter will attach to the flow head.*

2. Firmly push the two air flow tubes onto the two outlets on the 300L flow head if they are not already attached.
3. Carefully connect the other ends of the two air flow tubes into the Channel A1 input of the IXTA. Connect the red port to the red connector on the tubing and the white port to the white connector on the tubing.
4. Plug the PPG-320 pulse oximeter into the PT port on the front of the TA.

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*Figure HS-9-S3: The PPG-320 pulse oximeter and the flow head connected to the internal spirometer of the TA unit.*

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**Preparations Before Recording**

1. Please read the procedures for each exercise completely before beginning the experiment. You should have a good understanding of how to perform these exercises before making recordings.
2. The spirometer will monitor breathing from a subject. It is important that the subject is healthy and has no history of respiratory or cardiovascular problems.
3. The outlets on the flow head should always be in the upright position to avoid problems with condensation developing in the airflow tubes.
4. To reduce turbulence, the subject should place their lips around the outside of the opening of the flow head, or around the cardboard mouthpiece attached to the flow head.
5. Use a nose-clip to prevent air from entering or leaving the nose as the subject is breathing. Air that passes through the nose causes errors in the lung volume values.

6. Check the calibration of your spirometer on the Lung Volumes channel:
    - Click on the words Vol.Human (Air Flow), that are next to the title of the Lung Volumes channel, to open the computed function pull-down menu.
    - Select Setup Function from this pull-down menu to open the Spirometer Calibration Dialog window.
    - Check that the internal spirometer is being used by making sure the Type of Spirometer is the IXTA.
    - Make sure the reset time is set to "No Reset", and the first 10 seconds of the recording are used to zero the baseline of the Lung Volumes channel.
    - Enter 37 for temperature of exhaled air.
    - Click OK.
7. Allow the IXTA to warm up for 10 minutes before recording for the first time.

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# Experiment HS-9: PulseOx Challenge

## Exercise 1: Oxygen Saturation Level While Breathing at Rest

Aim: To determine the effect of breathing on the oxygen saturation level in the blood of a subject at rest.

Approximate Time: 20 minutes

### *Procedure*

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

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

2. Type **Resting** in the Mark box.
3. Click Record and then click the mark button.
4. Click the AutoScale All button. Notice the slowly moving wave on the Lung Volume channel. Record at least five to six breaths, which normally takes about forty-five seconds to record.
5. Click Stop to halt recording. Your data may look like Figure HS-9-L1.
6. 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 while resting.
2. Use the Display Time icons to adjust the Display Time of the Main window to show 30 seconds of breathing that are free of artifacts on the Main window.
3. Click AutoScale All.

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*Figure HS-9-L1: Pulse, oxygen saturation level, air flow, lung volumes, and heart rate during breathing at rest, displayed on the Main window.*

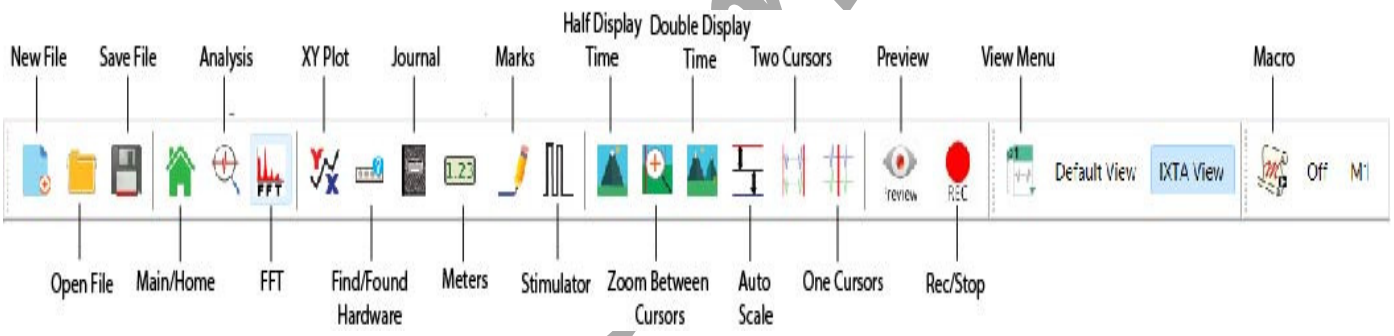


*Figure HS-9-L2: The LabScribe toolbar.*

5. Click on the Analysis window icon.
6. 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.
7. On the Lung Volume channel, use the mouse to place a cursor at the beginning of the inhalation of the first breath being measured. Place the second cursor at the end of the exhalation of the same 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.

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- **Mean Oxygen Saturation Level,** the value for Mean 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.

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 and the heart rate in each breath.
    - 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. 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 HS-9-L3: Pulse, oxygen saturation level, air flow, lung volumes, and heart rate of a resting subject displayed in the Analysis window.*

10. Record the values in the Journal using the one of the techniques described in Step 8, and in Table 1.
11. Repeat for two additional breath cycles.

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12. Average the values obtained for each parameter and enter the means in the Journal and in Table 1.

***Questions***

1. Does the subject's oxygen saturation level change in response to inhalation or exhalation?
2. Does the oxygen saturation level change during a normal breath? By how much?
3. Is there any significant difference in the mean oxygen saturation levels among the three breaths?

**Table HS-9-L1: Oxygen Saturation Levels during Breathing at Rest.**

| Subject | %O2 Saturation | | | Heart Rate (BPM) | | |
|---|---|---|---|---|---|---|
| _____ | Min | Max | Mean | Min | Max | Mean |
| Breath 1 | | | | | | |
| Breath 2 | | | | | | |
| Breath 3 | | | | | | |
| Mean | | | | | | |

**Exercise 2: Pulse Ox Challenge**

Aim: To measure the effect of your hypothesis on the subject's oxygen saturation level.

Approximate Time: 20 minutes

***SAMPLE TESTING IDEAS:*** Apnea, Hyperventilation, Bellows Breathing, Valsalva Maneuver

***Procedure***

1. The subject should sit quietly and breathe normally before this exercise begins. The subject should already be accustomed to breathing through a flow head.
2. Before the recording begins, instruct the subject about the breathing pattern you have chosen for this exercise:
    - After the 10 second calibration period, the subject should take 5 normal breaths through the flow head.
    - Then, the subject will perform whatever breathing parameter you have chosen.
    - When the subject resumes breathing, they should continue to breathe through the flow head until the breathing pattern is back to normal.

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3. Click on the Record button. After waiting ten seconds for the Lung Volume channel to zero, have the subject place the flow head in their mouth and begin breathing.
4. Type **Resting** in the Mark box. Click the mark button.
5. Click the AutoScale All button. Notice the slowly moving wave on the Lung Volume channel. Record four breaths, which normally takes about twenty seconds to record. Type **Hypothesis Started** in the Mark box.
6. Click the mark button as the subject performs the breathing parameter chosen.
7. While the subject is doing the experiment, type **Breathing Normally** in the Mark box. Click the mark button to mark the recording when the subject resumes breathing normally.
8. The subject should continue to breathe through the flow head until their breathing returns to normal.
9. Click Stop to halt recording. Your data should look like the image below.
10. Select Save in the File menu.

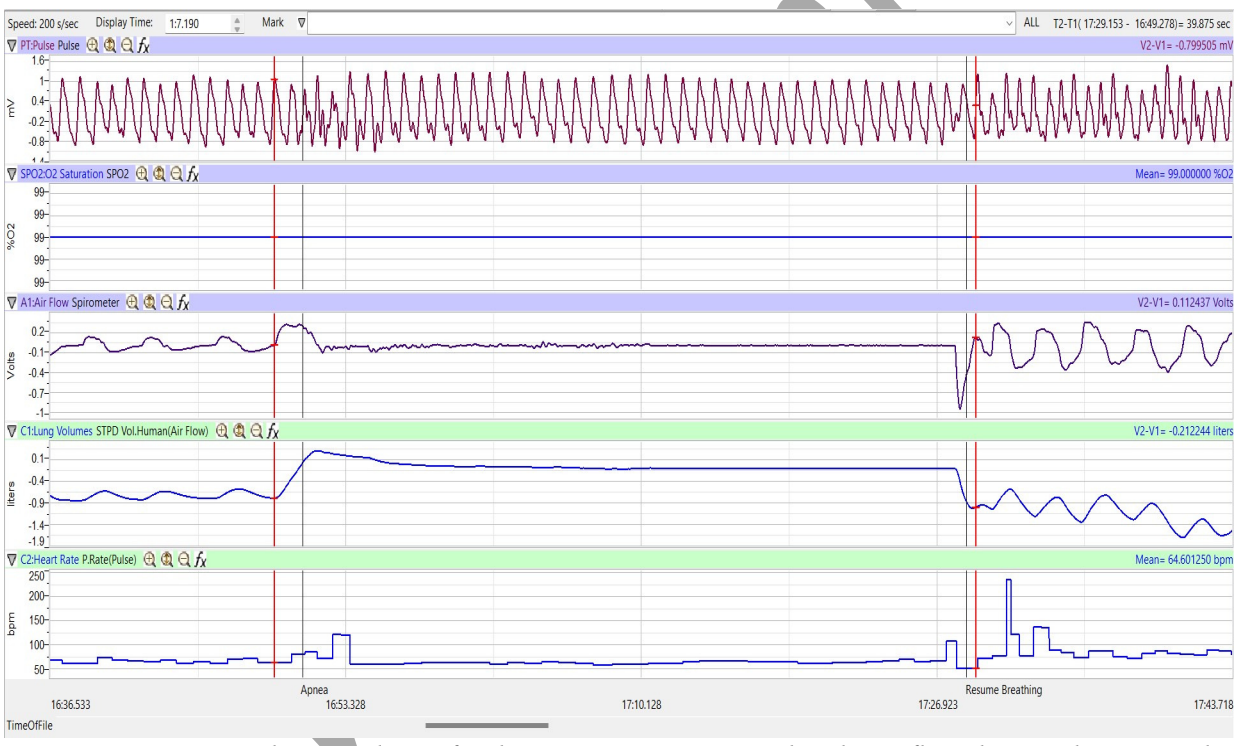


*Figure HS-9-L4: Example recording of pulse, oxygen saturation level, air flow, lung volumes, and heart rate before, during and after apnea, displayed in the Main window.*

### *Data Analysis*

1. Scroll to the recording of the subject's breathing before, during and after the experiment that is displayed in the Main window.

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2. Use the Display Time icons to adjust the Display Time of the Main window to show the normal breath before testing, the period of testing, and a couple of normal breaths after testing in the Main window.
3. Click AutoScale All.
4. Click on the Analysis window icon.

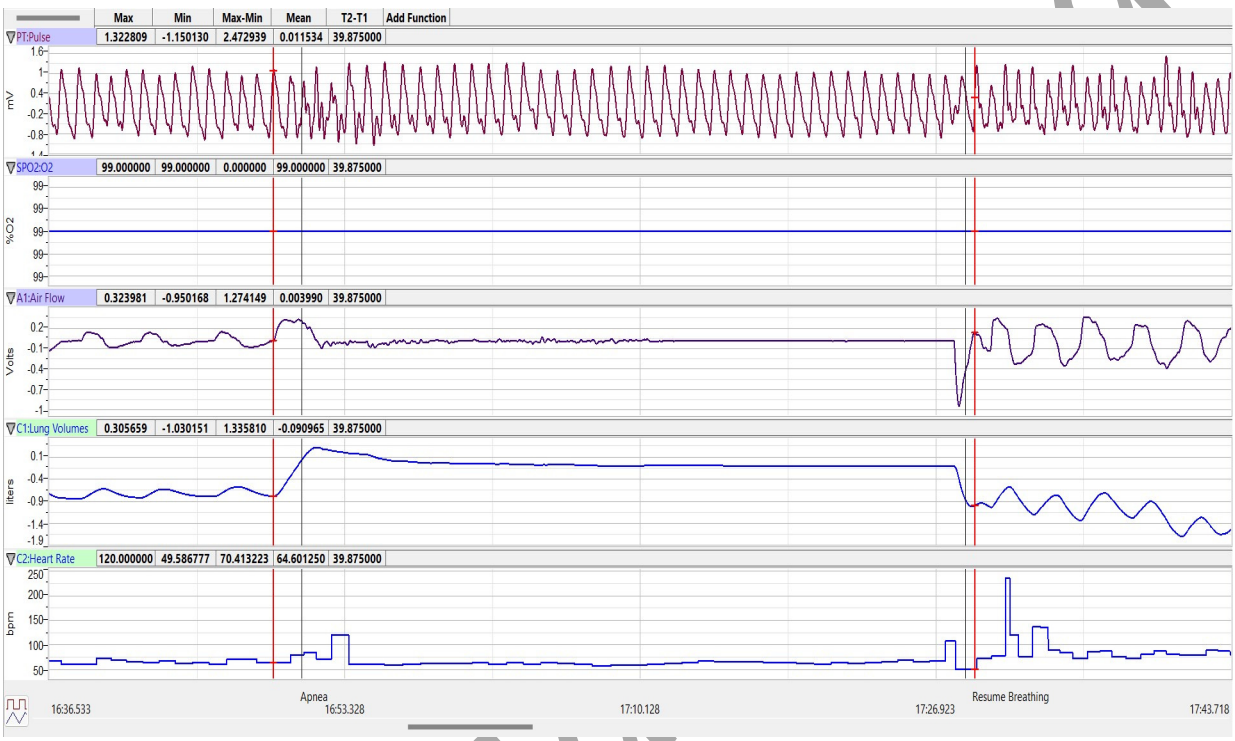


*Figure HS-9-L5: Sample data of pulse, oxygen saturation level, air flow, lung volumes, and heart rate before, during and after apnea, displayed in the Analysis window.*

5. On the Lung Volume channel, use the mouse to place a cursor at the beginning of the maximum inhalation that precedes the start of the test. Place the second cursor at the beginning of the first normal breath that follows the test. 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.
    - **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.
    - **Change(Δ) in Heart Rate**, the value for Max-Min on the Heart Rate channel.

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6. Record the values in the Journal using the one of the techniques described in Exercise 1, and on your own data table.
7. Measure the following parameters and record their values in the Journal:
    - **Response Time to Experimental Testing**. Place one cursor at the beginning of the maximal inhalation that precedes testing, and the second cursor at the first change in the oxygen saturation level during testing. The value for the T2-T1 function is the response time to apnea. Record the values in the Journal.
    - **Recovery Time from Testing**. Place one cursor at the end of testing, when the subject starts to exhale, and the second cursor at the return of the oxygen saturation level to normal. The value for the T2-T1 function is the recovery time from your testing parameter. Record the values in the Journal.
8. Click the Save button to save the file.

***Questions***

1. Does the subject's oxygen saturation level change in response to the breathing parameter chosen?
2. If so, by how much?
3. Is there any significant difference in the mean oxygen saturation levels before, during and after testing?
4. What are the physiological parameters involved in maintaining pulse oxygen saturation levels?
5. If the SpO2 did change, how long did it take to recover?

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