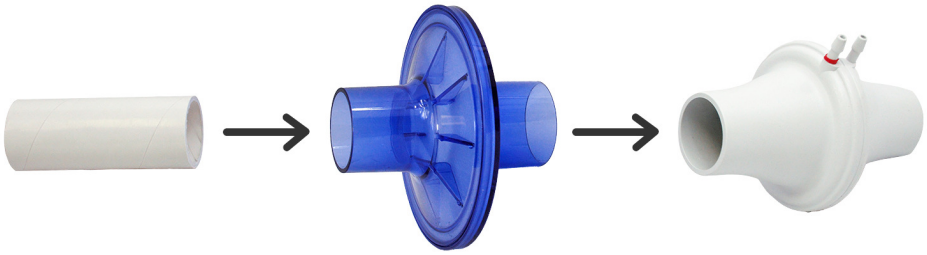
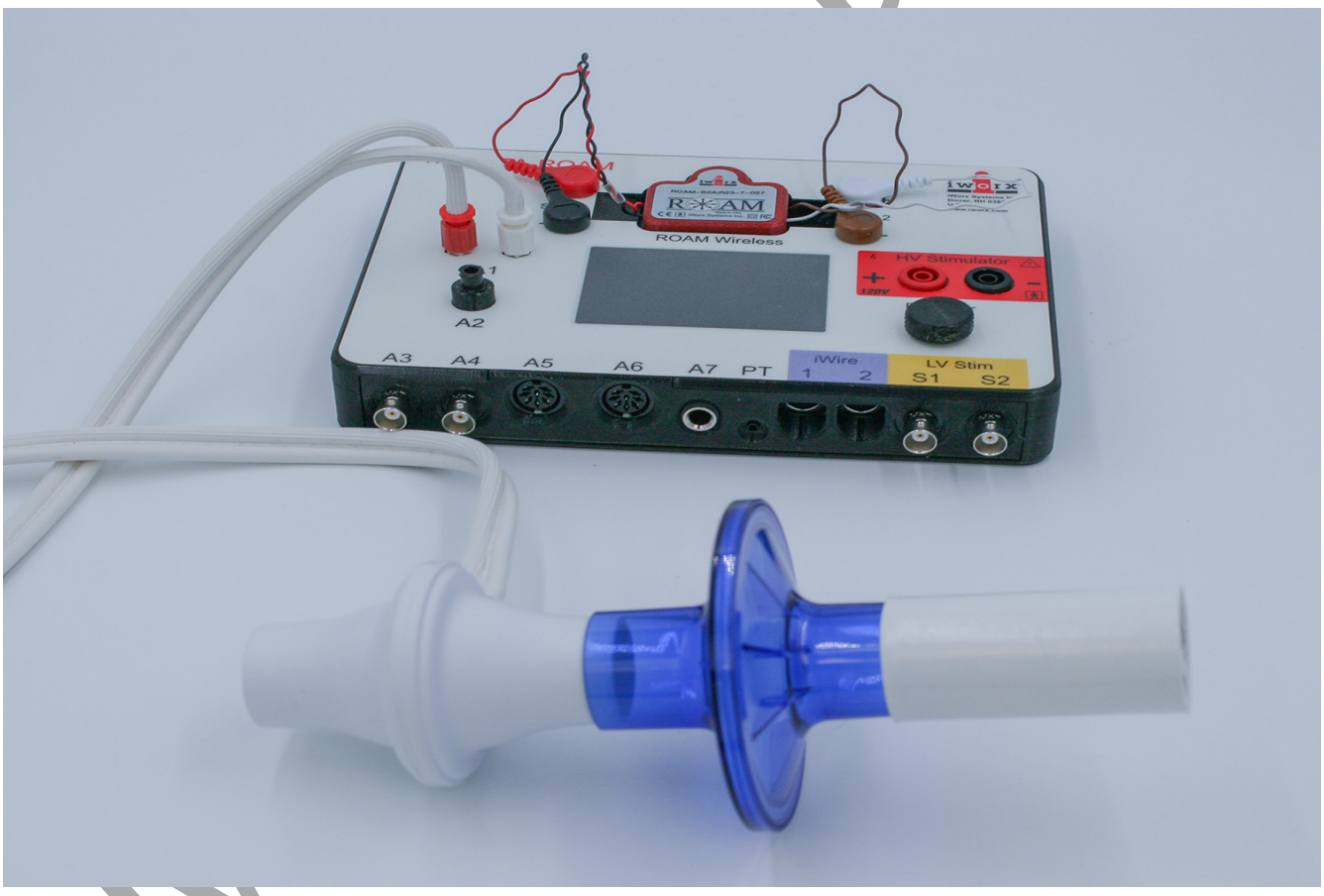
# Foundations Lab 4: Breathing Parameters

## Spirometer Setup

1. Connect the flow head and the airflow tubing, make sure the ridged tubing goes on the red port of the flow head.
2. Connect the other ends of the tubing to Channel A1 on the IXTA. Connect the red port to the red connector on the tubing.
3. If using, connect the student respiratory kit to the flow head as shown.





**Before Starting**

1. 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.
2. The ports on the flow head should always be facing up so that moisture does not collect in them.
3. The subject will wrap his/her mouth around the entire opening, making a good seal. He/she should also hold their nose or use a nose-clip to prevent any air from not going through the mouth.

**Exercise 1: Practice Breathing While Sitting**

Aim: To practice breathing through the flow head.

Approximate Time: 20 minutes

***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.***

***Procedure***

1. Instruct the subject to:
    - Sit quietly and become accustomed to breathing through the spirometer flow head.
    - Make sure to breathe through the "red port" side of 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 his or her mouth and place it on the table.
    - Place the nose clip on the nose or hold their nose.
2. Click Record. Do **NOT** begin breathing into the flow head until the first 10 seconds has elapsed.
3. After waiting ten seconds have the subject place the flow head in his or her mouth and begin breathing.
4. Have the subject turn away from the computer screen and breathe through the flow head for approximately 1 minute.
5. Click the AutoScale All button on the toolbar.
6. Click Stop.
7. Click Save As in the File menu, type a name for the file. Click on the Save button to save the data file.

***Data Analysis***

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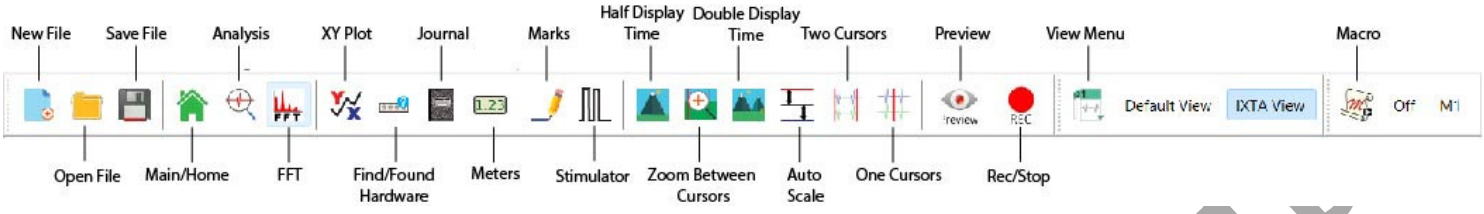

5. Use the "two mountains" icon to double the display time to show about 10 breaths on the screen.
6. On the Lung Volume channel, move one red cursor before the trough of a breath and move the other to the peak of that breath. Note that when the subject inhaled, the trace should go up.
7. Read the value for V2-V1 in the upper right corner of the Lung Volume channel. This measures the Tidal Volume (TV) of the subject. Measure a few breaths.
    - It should read about 500 ml (0.5 L).
    - If it is too low or too high, the subject is not breathing normally.
    - Repeat the Practice session if needed.

**Exercise 2: Measuring Lung Volumes While Sitting**

Aim: To measure normal breathing parameters in a sitting subject.

Approximate Time: 30 minutes

***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.***

***Procedure***

1. Have the subject place the nose clip on the nose or hold their nose.
2. Click Record. Do **NOT** begin breathing into the flow head until the first 10 seconds has elapsed.
3. After waiting ten seconds have the subject place the flow head in his or her mouth and begin breathing.
4. Click the AutoScale All button on the toolbar.
5. Have the subject breathe 10 normal breaths and then take an immediate, huge, deep breath in and then breathe all the way out. The subject should breathe normally again.

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6. Repeat step 5 two more times without stopping.
    - Breathe normally 10 times
    - Big in/out breath
    - Repeat – breathe 10 times; big in/out breath
    - Breathe normally 10 times
7. Click Stop.
8. Click AutoScale All.
9. Click Save to save your file.

Image showing regular breaths and a large in/out breath.

***Data Analysis – Measuring Lung Volumes***

***Note – you have the option of analyzing from the Main window or from the Analysis window.***

***Main Window Analysis:***

1. Use the "two mountains" icon to double the display time to show 1 full breathing set (10 breaths and the big in/out breath) on the screen at once.
2. On the Lung Volume channel, move one cursor before the trough of a normal breath and move the other to the peak of that breath.

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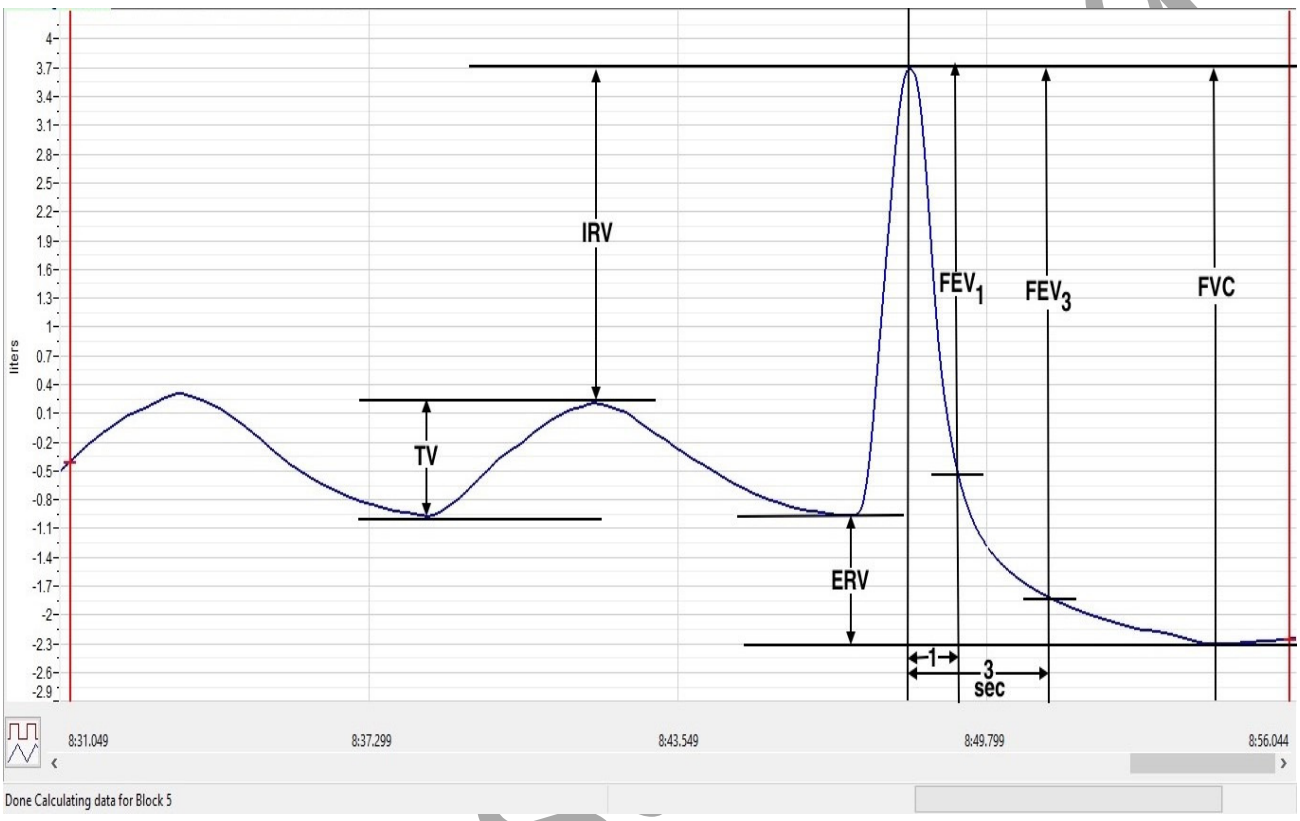
3. Read the value for V2-V1 in the upper right corner of the Lung Volume channel. This measures the Tidal Volume (TV) of the subject. Measure three breaths and calculate the mean Tidal Volume. Place the value in the Table.
4. Read the V2-V1 value for Inspiratory Reserve Volume (IRV). Place one cursor on the peak of the breath before the big breath in. Place the second cursor on the peak of the big "in" breath. Place the value in the Table.




5. Read the V2-V1 value for Expiratory Reserve Volume (ERV). Place one cursor on the trough of the breath before the big breath in. Place the second cursor on the trough of the big "out" breath. Place the value in the Table. Ignore the negative sign.
6. Read the V2-V1 value for Vital Capacity (FVC) by placing one cursor on the peak of the big in/out breath and the other on the trough of that breath. Place the value in the Table. Ignore the negative sign.
7. Measure the Forced Expiratory Volumes (FEV) at both 1 second and 3 seconds. Use V2-V1 for these values.
    - Keep the one cursor on the peak of the big in/out breath and move the other cursor towards the first, so that T2-T1 equals 1 second. Read V2-V1 and place that value in the table. Mathematically calculate the ratio by dividing FEV1 by FVC, add this to the table.

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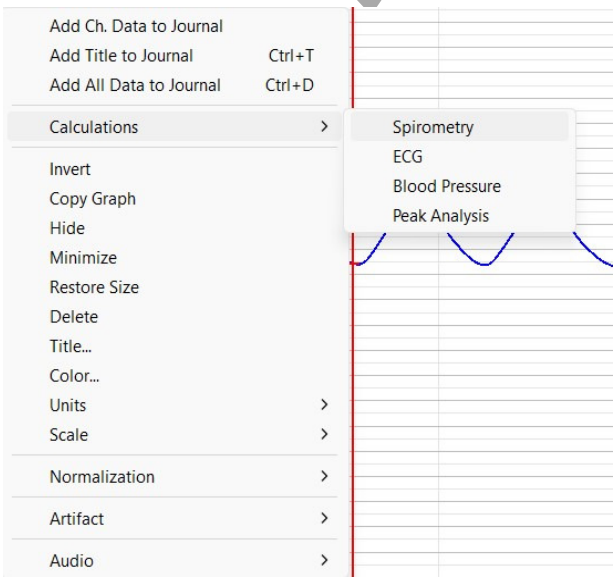
- Still keeping the one cursor on the peak of the big in/out breath, move the other cursor so that T2-T1 equals 3 seconds. Read V2-V1 and place that value in the table. Mathematically calculate the ratio by dividing FEV3 by FVC, add this to the table.

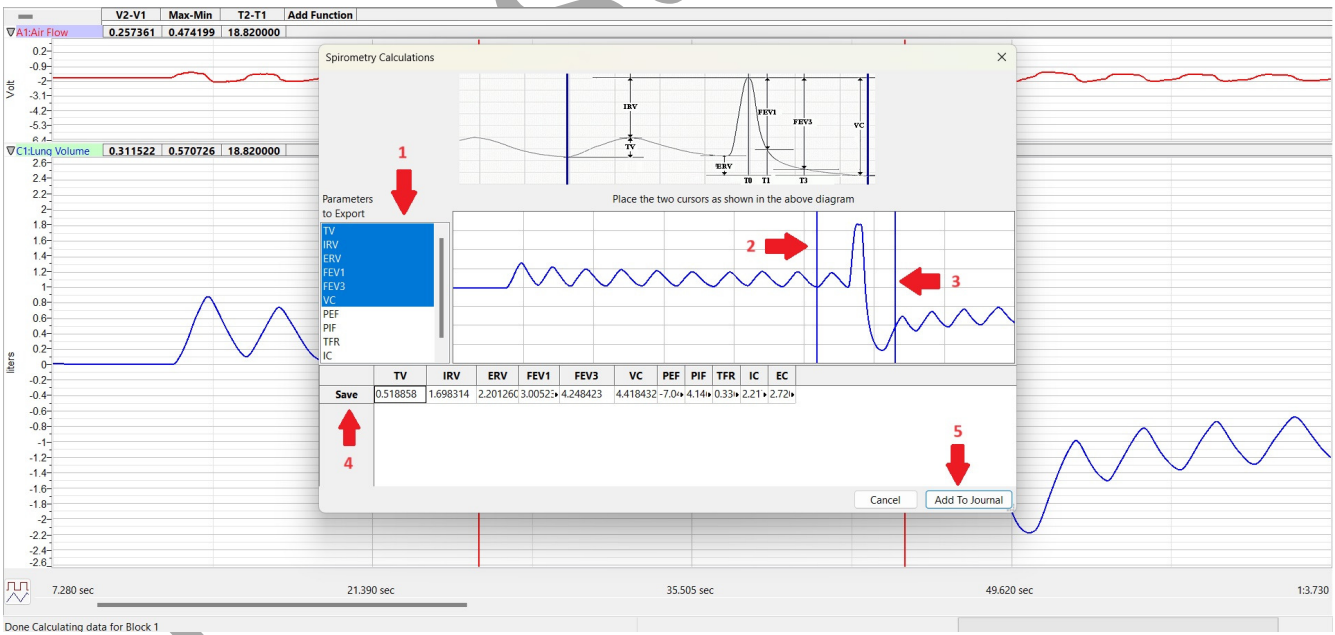
8. Repeat steps 2 through 7 for the next two breathing sets.

***Analysis Window Analysis***

1. Use the "two mountains" icon to double the display time to show 1 full breathing set (10 breaths and the big in/out breath) on the screen at once.

2. Click the Analysis window icon.
3. Right click in the Spirometry graph.
4. Click Calculations – Spirometry
5. Using the image below:
    1. Control Click to choose the Spirometry parameters to be measured
        - TV – Tidal Volume
        - IRV – Inspiratory Reserve
        - ERV – Expiratory Reserve
        - FEV1 – Forced Expired Volume (1 sec)
        - FEV3 - Forced Expired Volume (3 sec)
        - VC – Vital Capacity




Lab

2. Move the blue vertical cursors so one is on the trough of the full regular breath before the big in/out breath and the 2nd is on the slight up-slope right after the trough of the big out breath. Refer to the image for placement of the cursors.
3. Click Save on the left side of the chart.
4. Click Add To Journal on the lower right of the Spirometry Calculations window.
5. Click the "x" in the upper right to close the window.

6. Repeat all the above steps for the other 2 full breathing cycles including the big in/out breaths.

7. Click the Journal icon and then click Table. All your values for the breathing parameters will be shown here.

Send data to Journal

Table Editor

| * | A | B | C | D | E | F |
|---|---|---|---|---|---|---|
| 1 | | | | | | |
| 2 | TV | IRV | ERV | FEV1 | FEV3 | VC |
| 3 | 0.518858 | 1.698314 | 2.201260 | 3.005230 | 4.248423 | 4.418432 |
| 4 | 0.491328 | 2.148636 | 2.056581 | 3.677725 | 4.180285 | 4.696546 |
| 5 | 0.369981 | 2.748699 | 0.416174 | 1.780541 | 2.936863 | 3.534854 |
| 6 | | | | | | |

## Lung Volumes and Capacities

| | Description | Average Value |
|---|---|---|
| **Tidal volume (TV)** | Volume of air entering or leaving lungs during a single breath | 500 ml |
| **Inspiratory reserve volume (IRV)** | Extra volume of air that can be maximally inspired over and above the typical resting tidal volume | 3000 ml |
| **Inspiratory capacity (IC)** | Maximum volume of air that can be inspired at the end of a normal quiet expiration (IC =IRV + TV) | 3500 ml |
| **Expiratory reserve volume (ERV)** | Extra volume of air that can be actively expired by maximal contraction beyond the normal volume of air after a resting tidal volume | 1000 ml |
| **Residual volume (RV)** | Minimum volume of air remaining in the lungs even after a maximal expiration | 1200 ml |

***Questions***

1. Are the lung volumes the same in all students?
2. Combine class data to see whether there is any correlation between tidal volume or vital capacity and gender, smoking, or apparent fitness.

***NOTE: This experiment can be expanded by having the subject exercise (example - by running for about 5 minutes) and then coming back and repeating Exercise 2 and the data analysis.***

Work in Lab

**Table: Lung Volume Parameters.**

| | Breath Set 1 | Breath Set 2 | Breath Set 3 |
|---|---|---|---|
| Mean (from 3 breaths) Tidal Volume(TV) | | | |
| Inspiratory Reserve Volume (IRV) | | | |
| Expiratory Reserve Volume (ERV) | | | |
| Vital Capacity (FVC) | | | |
| Forced Expiratory Vol-1sec ($FEV_1$) | | | |
| Forced Expiratory Vol-3sec ($FEV_3$) | | | |
| • $FEV_1$/VC Ratio | | | |
| • $FEV_3$/VC Ratio | | | |

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