
Experiment B-41



The Lungs and Spirometry Parameters



Objectives

- To learn about the mechanism of breathing.
- To learn about lung volumes and capacities.
- To compare these parameters before and after physical activity.
- To compare these parameters among different students.

Modules and Sensors

- PC + NeuLog application
- USB-200 module 
- NUL-216 Spirometer logger sensor 

Materials

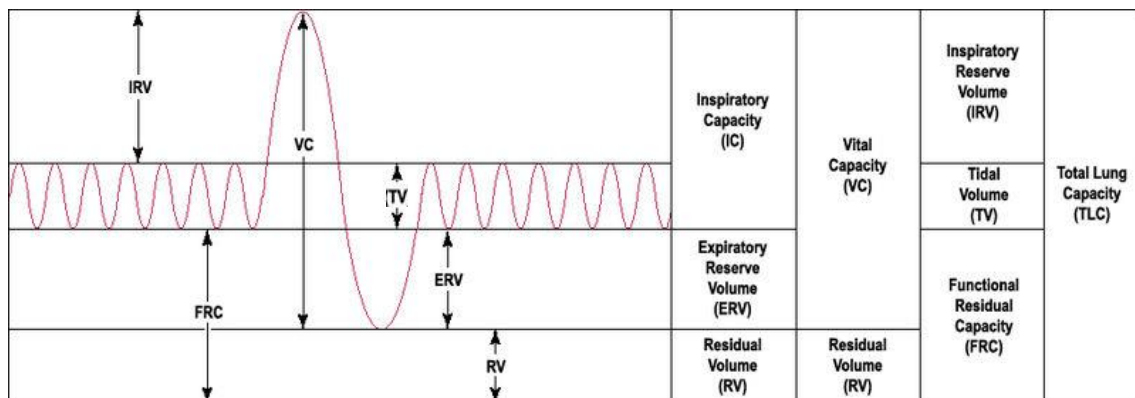
- Spirometer papers (included with the sensor)

Introduction

The chest contains two lungs made up of sections called lobes, and are protected by the ribcage. The lungs bring oxygen into the body and remove carbon dioxide. Air is breathed through the nose, mouth or both. The nose is the preferred route since it is a better filter for large particles than the mouth. However, when a large amount of air is needed, the mouth route is better.

The diaphragm is a large muscle located under the lungs. **Inhalation** occurs when the diaphragm moves down, the ribs flare outward, the lungs expand and air is drawn in. **Exhalation** occurs when the diaphragm relaxes and air leaves the lungs.

How much air do we breathe? The normal amount of air that we breathe in and out when we are at rest is called **tidal volume (TV)**. An average tidal volume is around half a liter. We can also inhale a very large amount of air and then exhale all the air we can, the volume of that exhaled air is called our **vital capacity (VC)** (typically 3.1-4.8 liters).



We cannot exhale all the air from our lungs. There is approximately 1.2 liters of air that remains in our respiratory tracts; it is called the **residual volume (RV)**.

The total amount of air that we can hold (the vital capacity plus the residual volume) is the **total lung capacity (TLC)**. Its volume is approximately 4.2-6 liters.

Procedure



Experiment setup

1. Make sure you have spirometer papers so that several students can use the same spirometer one after the other.

Note:

The spirometer logger sensor is designed for educational use only and may not be used for medical diagnose. If you suffer from asthma or you are not feeling well, do not conduct this experiment.

Sensor setup


2. Connect the USB-200 module  to the PC.
3. Check that the spirometer sensor  is connected to the USB-200 module.

Note:

The following application functions are explained in short. It is recommended to practice the NeuLog application functions (as described in the user manual) beforehand.

4. Run the NeuLog application and check that the spirometer sensor is identified.

Settings


5. Click on the **Run Experiment** icon  and set the:
Experiment duration to 1 minute
Sampling rate to 10 per second


Testing and measurements

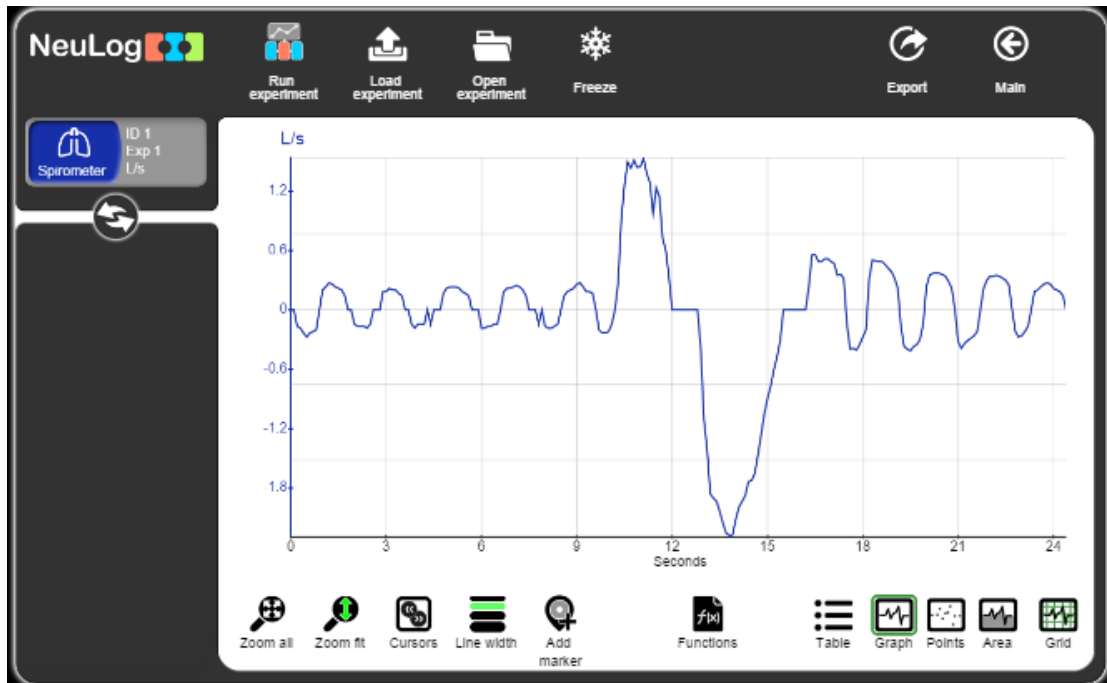
Note:



This experiment should be carried out in pairs.



6. Roll the paper and insert it into the larger inlet of the spirometer. While one student breathes in and out through the spirometer sensor, another student should start the experiment and keep track of it.
7. Tightly attach your lips to the rolled paper and block the air flow through your nose with your hand or a clip.
8. Click on the **Record** icon  to start the measurement.

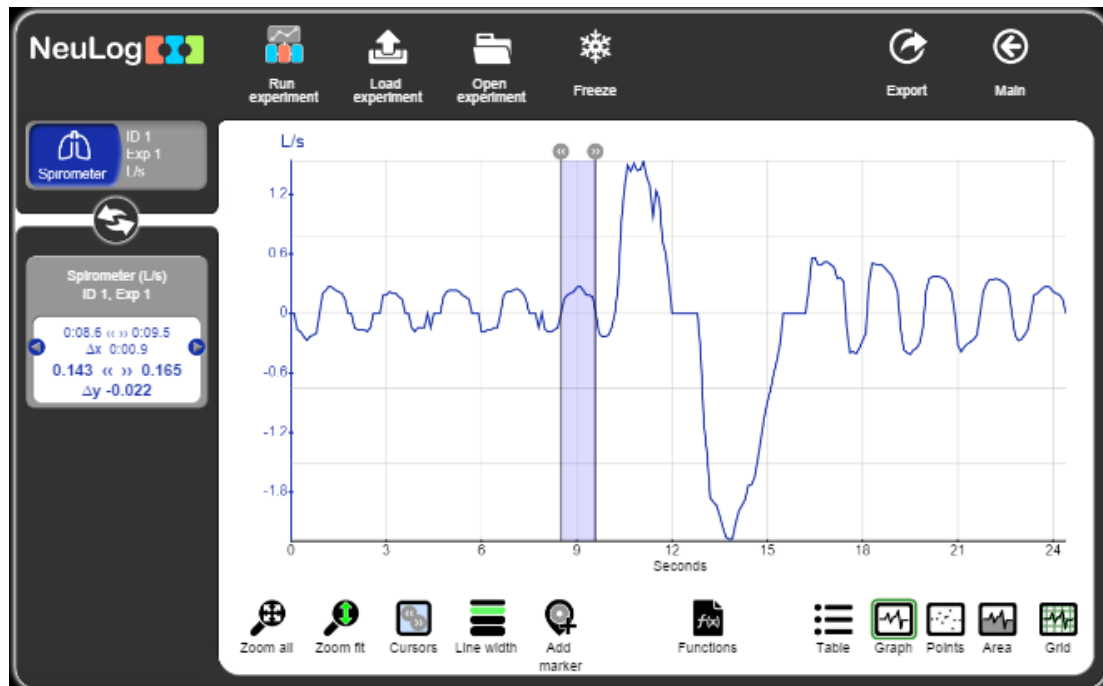
9. Breathe regularly in and out a few times. Afterwards, inhale as hard as you can and then exhale as hard as you can. Keep on breathing regularly for a few times and stop the experiment.
10. Click on the **Zoom fit** icon .
11. Your graph should be similar to the following:




12. Click on the **Export** icon  and then on the **Save value table (.CSV)** button to save your graph.
13. Click on the  icon to go back to the graph.

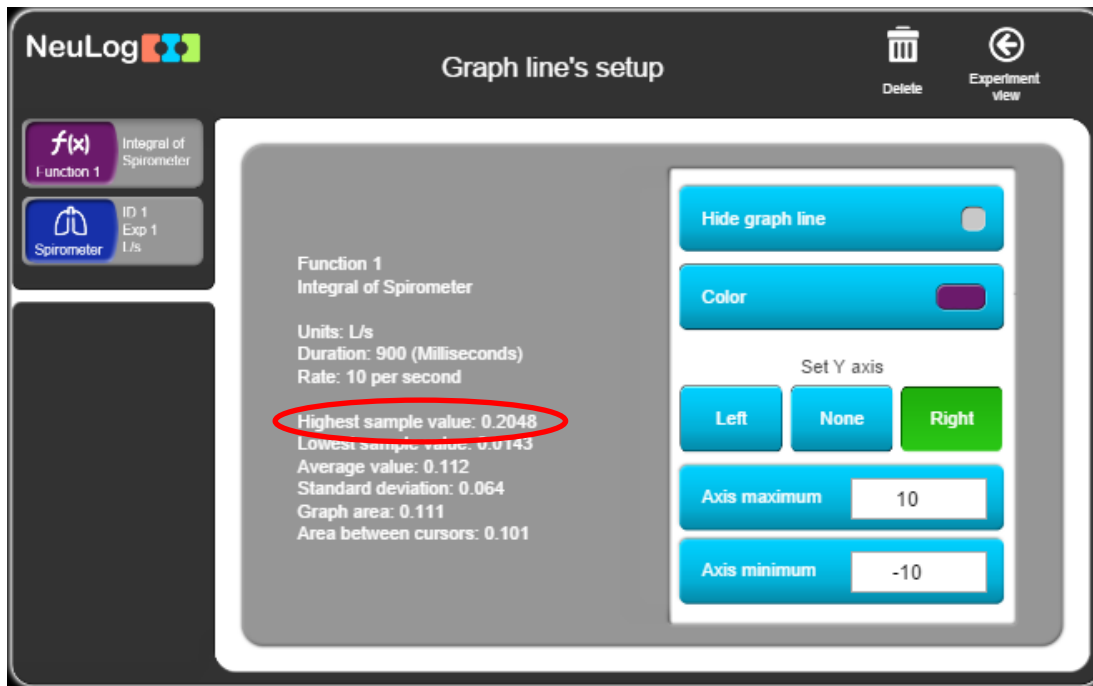
We can calculate the **tidal volume (TV)** and the **vital capacity (VC)**:

14. Click on the **Cursors** icon  and choose an area of the graph that includes a regular inhale or exhale.



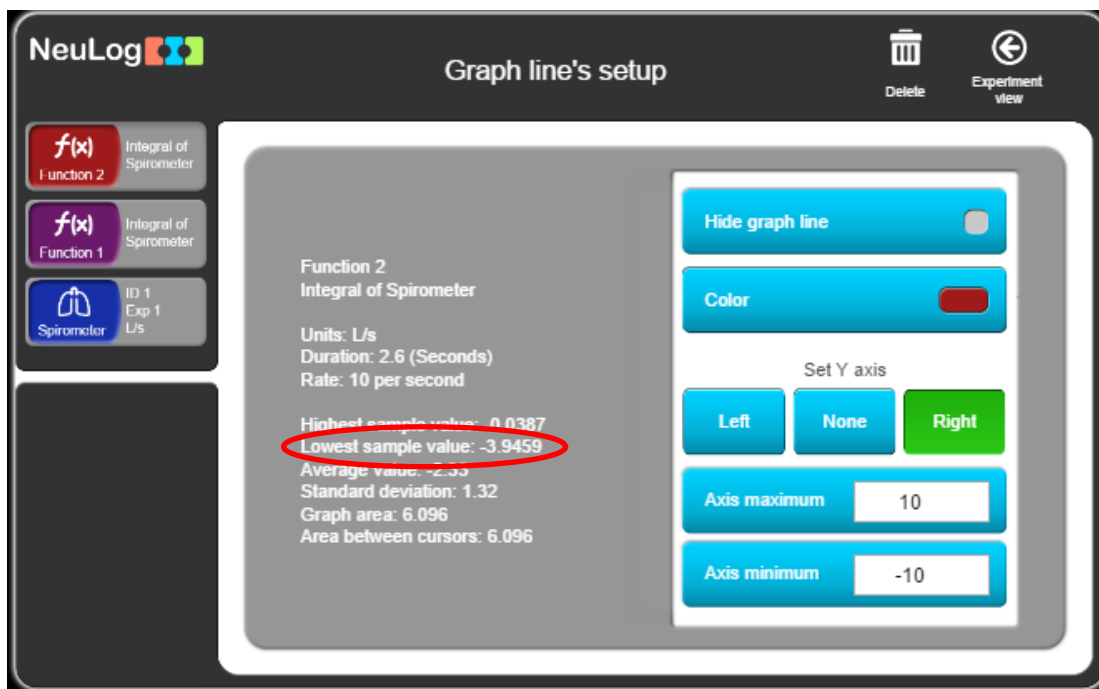
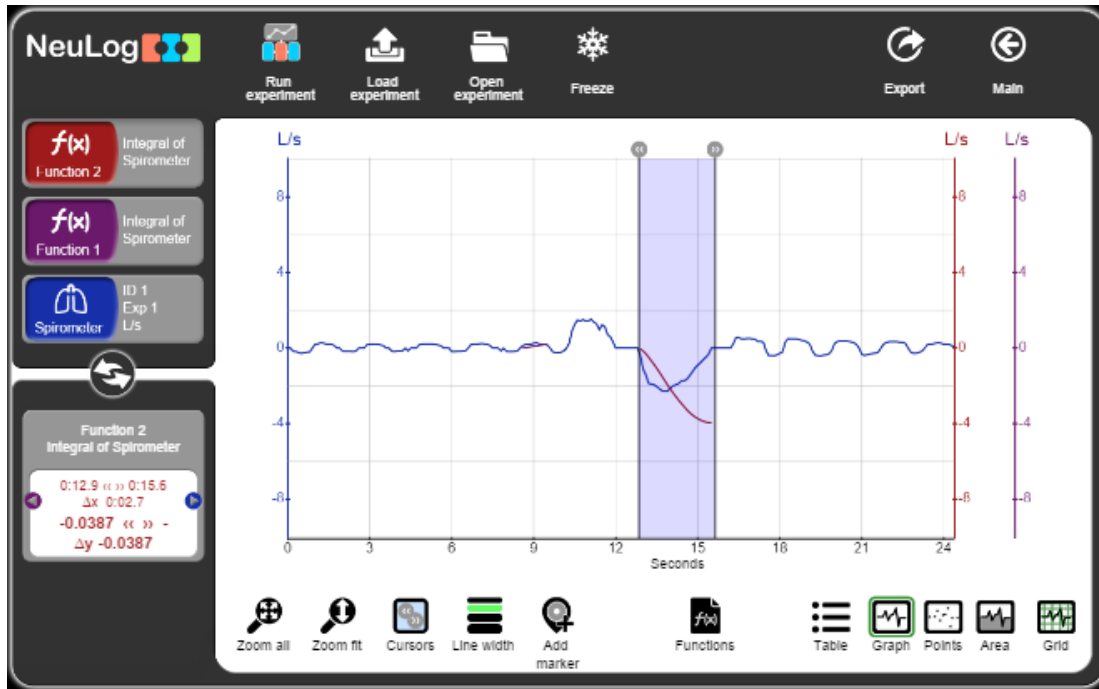
15. Click on the **Functions** icon , and then on the Functions button.
16. Click on **Integral of A**.
17. Click on the **Integral of Spirometer** module box on the left of the screen.

18. Look at the highest sample value, it is the area beneath this part of the graph:



19. You will notice that the area beneath the curve is calculated. The area is equal to **the tidal volume (TV)**, which in the sample experiment is 0.2 L.

20. Repeat these steps but this time choose the part of the measured maximum exhaled air. This is the **vital capacity (VC)**, which in the sample experiment is equal to 3.95 L.



Challenge research

21. Measure your tidal volume after some physical activity.
22. Compare your results with other students.

Summary questions

1. How much is your estimated total lung capacity (TLC)?
2. How did the physical activity affect your tidal volume? Explain.
3. What were the differences among different students? What were the differences between boys and girls? Explain.