

# Human Respiration Laboratory Experiment

## By

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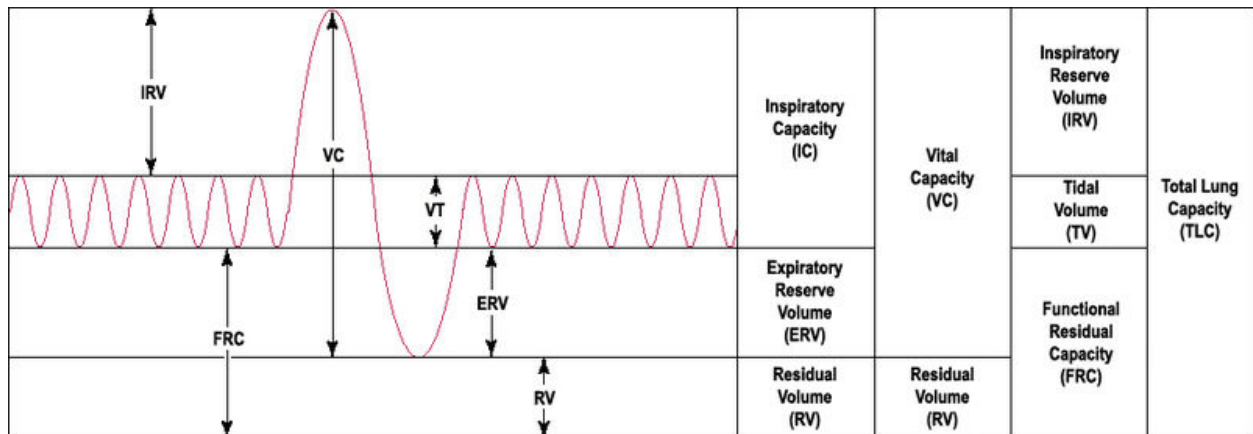
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*(Some text taken directly from ADInstruments protocol guide)*

### Human Respiration

Respiration is responsible for gas exchange throughout the entire body. This occurs in the lungs where blood exchanges carbon dioxide for oxygen and in the tissues of the body where the oxygen is given up by the blood for carbon dioxide. Every time gas is exchanged in the body, whether it is over an alveoli or another body tissue, a system of capillaries provide a surface which the gases can diffuse over. Ventilation is the act of breathing, or inhaling and exhaling. The area of the brain in charge of ventilation is the brain stem, the medulla oblongata, and the pons which receive direction from the autonomic nervous system. The active part of breathing is inhaling, this is accomplished when the diaphragm contracts producing negative pressure in the lungs which causes air to flow into the lungs. Exhaling happens when the lungs return back to their normal size and the air is forced out as a result, this makes exhaling a passive process.

To measure respiration in humans there are a few terms that are necessary to understand. The first is total lung capacity, which is the total amount a person's lungs can hold. This is very hard to measure because of what is known as the residual volume. The residual volume is the amount that is always left in a person's lungs. The vital capacity is the amount of air that is exchanged between inhaling and exhaling when the person tries to inhale and exhale as much as they can. The vital capacity plus the residual volume is the total lung capacity. The tidal volume is the normal amount of air that is exchanged between inhaling and exhaling. The other terms in the chart below should also be looked at.



<http://en.wikipedia.org/wiki/File:LungVolume.jpg>

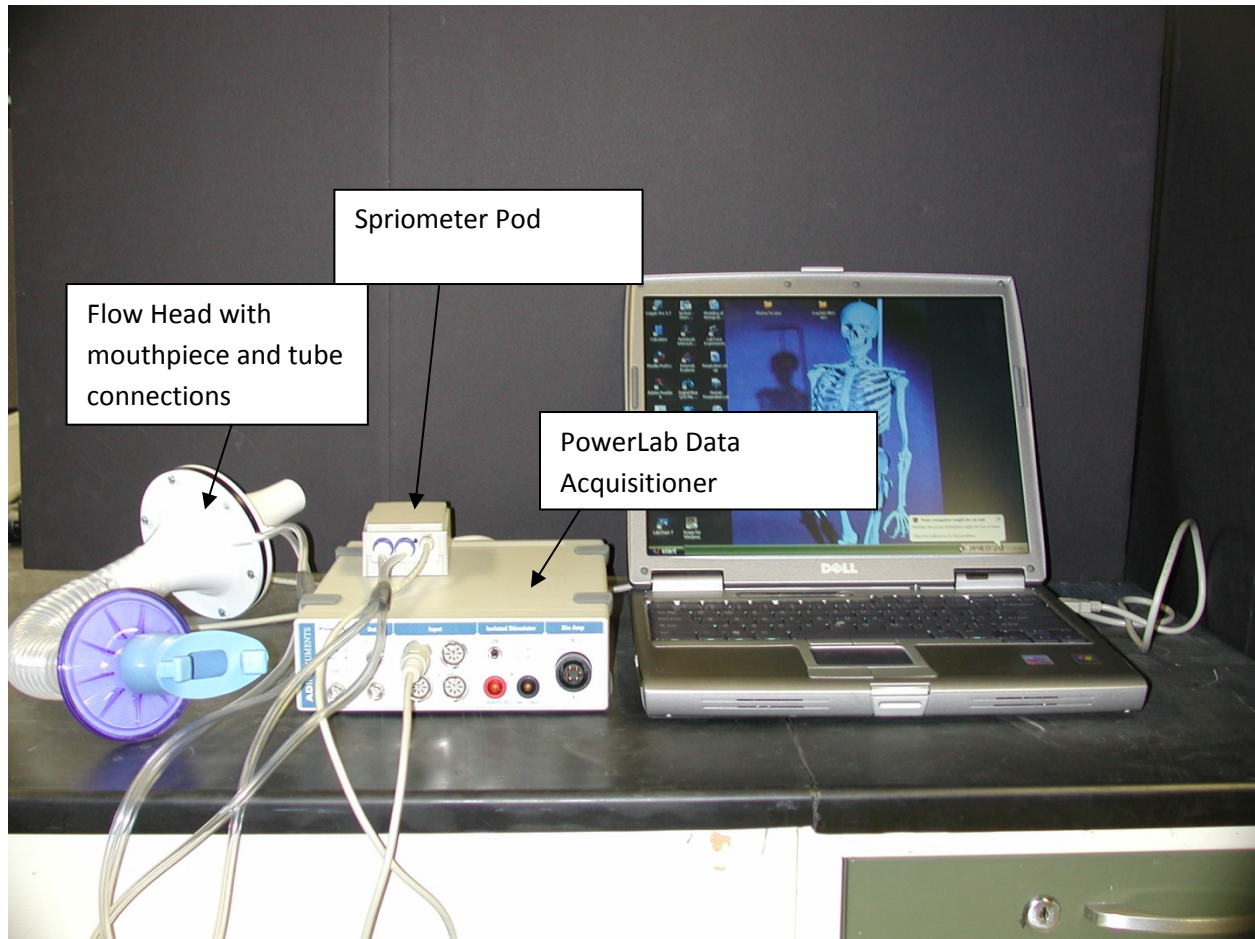


Figure 1: The image above shows the setup for the respiration experiment.



Figure 2: The image above shows the proper use of the flow head for the respiration experiment.

#### Lab Procedure

1. Connect the Spirometer Pod to Input 1 on the PowerLab.
2. Since the Spirometer Pod is sensitive to temperature and tends to drift during warm-up, turn on the PowerLab for at least 5 minutes before use. To prevent temperature drift due to heating of the Pod, place it on a shelf or beside the PowerLab, away from the PowerLab power supply.
3. Connect the two plastic tubes from the respiratory flow head to the short pipes on the back of the Spirometer Pod.
4. Attach Clean Bore tubing, a filter and mouthpiece to the flow head.
5. Make sure you have access to the following equipment for different parts of the experiment.
  - a. Tape measure for measuring volunteer height.
  - b. Duct tape and a pen, or sharpened pencil, for the simulated airway restriction exercise.
  - c. Extra mouthpieces and disposable air filters for **each** volunteer.
6. Leave the flow head apparatus undisturbed on the bench and click the Zero Pod button. This will reset the offset of the Flow channel to zero.

7. Click Start. The volunteer can now put the mouthpiece in his or her mouth, and hold the flow head carefully with two hands. In order to calculate volume from the flow recording correctly it is crucial that recording be started prior to breathing through the flow head.
8. Put the nose clip on the volunteers nose. This ensures that all air breathed passes through the mouthpiece, filter and flow head.
9. Observe the trace. The signal should show a downward deflection on expiration. If the signal deflects upward, stop recording and either reverse the orientation of the flow head, or swap the tubular connections to the Spirometer Pod.
10. When the volunteer has become accustomed to the apparatus and is breathing normally through it, stop recording and proceed to the next page.
11. Leave the flow head apparatus undisturbed on the bench and click the Zero Pod button. This will reset the offset of the Flow channel to zero.
12. Click Start. The volunteer can now put the mouthpiece in his or her mouth, and hold the flow head carefully with two hands. In order to calculate volume from the flow recording correctly it is crucial that recording be started prior to breathing through the flow head.
13. Put the nose clip on the volunteers nose. This ensures that all air breathed passes through the mouthpiece, filter and flow head.
14. Observe the trace. The signal should show a downward deflection on expiration. If the signal deflects upward, stop recording and either reverse the orientation of the flow head, or swap the tubular connections to the Spirometer Pod.
15. When the volunteer has become accustomed to the apparatus and is breathing normally through it, stop recording and proceed to the next page.
16. Re-zero the Spirometry Pod using the Zero Pod button. Remember that the flow head must be left undisturbed on the bench during the zeroing process.
17. Click Start. Once recording has started ask the volunteer to pick up the flowhead and start breathing through it.
18. Have the volunteer perform a full expiration through the flowhead and then continue normal tidal breathing for one minute.
19. While recording continues add the comment "Volume correction procedure" to the data.
20. At the end of one minute, have the volunteer perform another full expiration.
21. Click Stop. The volunteer can now stop breathing through the flow head and remove the nose clip.
  
22. Re-zero the Spirometer Pod using the Zero Pod button. Remember that the flow head must be left undisturbed on the bench during the zeroing process.
23. Click Start. Once recording has started ask the volunteer to replace the nose clip and breathe normally through the flow head. Record normal tidal breathing for 1 to 2 minutes.
24. During recording add the comment "Normal tidal breathing" to the data.
25. After the tidal breathing period and at the end of a normal tidal expiration, ask the volunteer to **inhale** as deeply as possible and then **exhale** as deeply as possible. Afterwards, allow the volunteer to return to normal tidal breathing then stop recording.
26. Add the comment "Lung volume procedure" to this deep breath.

27. Examine the normal tidal breathing data. Calculate how many breaths there are in a one-minute period (bpm). Type this into the appropriate cell in the table.
28. Determine the volume of a single tidal inspiration by dragging the Marker from its box to the Volume channel at the start of a normal tidal inspiration. Move the Waveform Cursor to the next peak on the Volume channel (this should be 0.5 to 1.5 s to the right of the Marker).
29. Click to place the selected data in the Value panel and drag the value from the Value panel into the Tidal Volume ( $V_T$ ) cell of the table. Expired minute volume will be calculated by LabTutor for you.
30. Repeat steps 2-3 to determine the Inspiratory Reserve Volume (IRV) and Expiratory Reserve Volume (ERV). Note, the Marker should remain at the start of a normal tidal inspiration (trough) for the ERV procedure, it should be moved to the end of a normal tidal inspiration (peak) for the IRV procedure.
31. Click on this link and use the calculator to determine predicted values for Residual Volume (RV).
32. Re-zero the Spirometer Pod using the Zero Pod button. Remember that the flow head must be left undisturbed on the bench during the zeroing process
33. Click Start. Once recording has started ask the volunteer to replace the nose clip and breathe normally through the flow head.
34. Prepare a comment "FVC procedure".
35. Have the volunteer breathe normally for 10 to 20 seconds.
36. Ask the volunteer to **inhale** and then **exhale** as **forcefully**, as **fully** and for **as long** as possible, until no more air can be expired.
37. In the comment box, click Add.
38. Allow the volunteers breathing to return to normal, then click Stop.
39. Your recording should resemble this.
40. Repeat this procedure twice more, so that you have three separate Forced Vital Capacity recordings.
41. Using the Waveform Cursor and the Marker tool as necessary, examine each of the three Forced Vital Capacity recordings (FVC).
42. On the Flow channel determine which of the three recordings shows a maximum Peak Inspiratory Flow (PIF).
43. Click to place this data in the Value panel. Drag this value into the appropriate cell in the table.
44. Repeat this step to determine the maximum Peak Expiratory Flow (PEF), and enter this into the table also.
45. On the Volume channel determine which of the three recordings shows a maximal FVC.
46. Place the Marker on the peak inhalation in the Volume channel and move the Waveform Cursor to the maximal expiration also on the Volume channel. Click to place the selected data in the Value panel, and drag the value from the Value panel into the FVC cell of the table.
47. Using the same recording as gave a maximal FVC measure the Forced Expiratory Volume in 1 second ( $FEV_1$ ). Place the Marker on the peak inhalation in the Volume channel, move the pointer to a time 1.0 s from the peak. Click to place the selected data in the Value panel, and drag the value from the Value panel into the FVC cell of the table.
48. Remove the filter attachment from the clean-bore tubing.

49. Cover the end of the filter with duct tape.
50. Use a pen or a sharpened pencil to make a hole in the duct tape over the filter about a half centimeter in diameter.
51. Reattach the filter to the clean-bore tubing.
52. Repeat the procedures in Exercise 2, as described below.
53. Re-zero the Spirometer Pod using the Zero Pod button. Remember that the flow head must be left undisturbed on the bench during the zeroing process
54. Click Start. Once recording has started ask the volunteer to replace the nose clip and breathe normally through the flow head.
55. Prepare a comment "FVC restricted".
56. Have the volunteer breathe normally for 10 to 20 seconds.
57. Ask the volunteer to **inhale** and then **exhale** as **forcefully**, as **fully** and for **as long** as possible, until no more air can be expired.
58. In the comment box, click Add.
59. Allow the volunteers breathing to return to normal, then click Stop.
60. Repeat this procedure twice more, so that you have three separate Forced Vital Capacity recordings.
61. Using the Waveform Cursor and the Marker tool as necessary, examine each of the three Forced Vital Capacity recordings (FVC).
62. On the Flow channel determine which of the three recordings shows a maximum Peak Inspiratory Flow (PIF).
63. Click to place this data in the Value panel. Drag this value into the appropriate cell in the table.
64. Repeat this step to determine the maximum Peak Expiratory Flow (PEF), and enter this into the table also.
65. On the Volume channel determine which of the three recordings shows a maximal FVC.
66. Place the Marker on the peak inhalation in the Volume channel and move the Waveform Cursor to the maximal expiration also on the Volume channel. Click to place the selected data in the Value panel, and drag the value from the Value panel into the FVC cell of the table.
67. Using the same recording as gave a maximal FVC measure the Forced Expired Volume in 1 second ( $FEV_1$ ). Place the Marker on the peak inhalation in the Volume channel, move the pointer to a time 1.0 s from the peak. Click to place the selected data in the Value panel, and drag the value from the Value panel into the FVC cell of the table.
68. Re-zero the Spirometer Pod using the Zero Pod button. Remember that the flow head must be left undisturbed on the bench during the zeroing process
69. Click Start. Once recording has started ask the volunteer to replace the nose clip and breathe normally through the flow head.
70. Prepare a comment "FVC volunteer 2".
71. Have the volunteer breathe normally for 10 to 20 seconds.
72. Ask the volunteer to **inhale** and then **exhale** as **forcefully**, as **fully** and for **as long** as possible, until no more air can be expired.
73. In the comment box, click Add.
74. Allow the volunteers breathing to return to normal, then click Stop.
75. Repeat this procedure up to twice more, so that you have three separate Forced Vital Capacity recordings.

76. Repeat for up to another two volunteer, .
77. Using the Waveform Cursor and the Marker tool as necessary, examine each of the three Forced Vital Capacity recordings (FVC).
78. On the Flow channel determine which of the three recordings shows a maximum Peak Inspiratory Flow (PIF).
79. Click to place this data in the Value panel. Drag this value into the appropriate cell in the table.
80. Repeat this step to determine the maximum Peak Expiratory Flow (PEF), and enter this into the table also.
81. On the Volume channel determine which of the three recordings shows a maximal FVC.
82. Place the Marker on the peak inhalation in the Volume channel and move the Waveform Cursor to the maximal expiration also on the Volume channel. Click to place the selected data in the Value panel, and drag the value from the Value panel into the FVC cell of the table.
83. Using the same recording as gave a maximal FVC measure the Forced Expired Volume in 1 second ( $FEV_1$ ). Place the Marker on the peak inhalation in the Volume channel, move the pointer to a time 1.0 s from the peak. Click to place the selected data in the Value panel, and drag the value from the Value panel into the FVC cell of the table.