Powerlab Tutorial: Spirometer

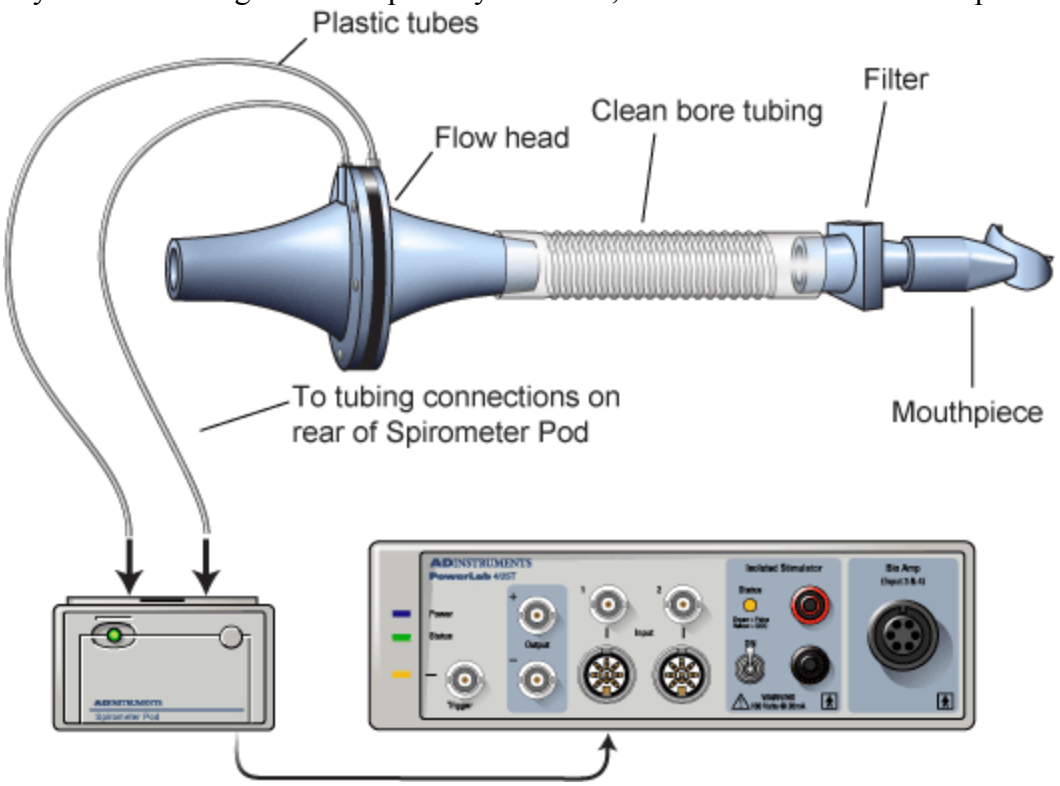
Equipment Setup

Procedure

1. Connect the Spirometer Pod to the Pod Port on 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.

- Tape measure (inches) for measuring volunteer height.
- Duct tape and a pen, or sharpened pencil, for the simulated airway restriction exercise.
- Extra mouthpieces and disposable air filters for each volunteer.

⚠ If you are suffering from a respiratory infection, do not volunteer for this experiment.



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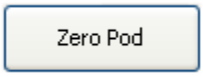
Zeroing the Spirometry Pod

The Spirometry Pod is susceptible to thermal drift of the baseline signal. In order to give appropriate volume measurements it is important to always reset the baseline by clicking the Zero Pod button prior to making any new recording.

Zero Pod button

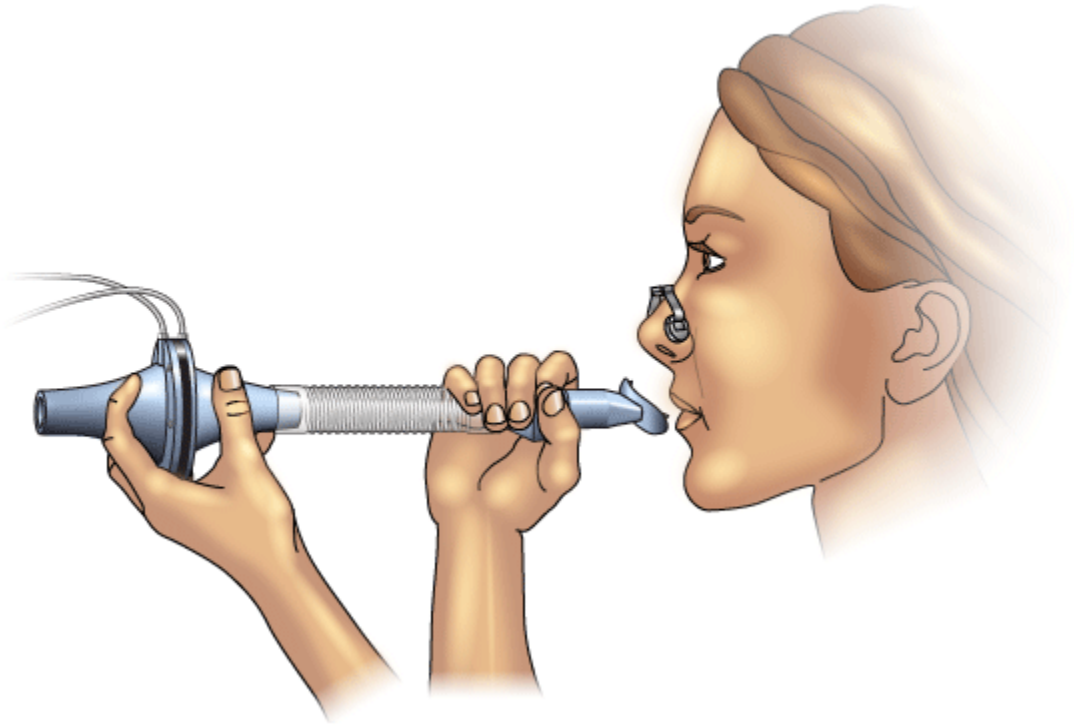


The Zero Pod button resets the voltage offset from the Spirometer Pod to zero.

It should be clicked prior to starting any recording during the Respiratory Air Flow and Volume experiment.

Procedure

1. 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.
2. 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 prevent water vapor collecting in the two plastic tubes from the flow head they should always be pointing upwards.



3. Put the nose clip on the volunteers nose. This ensures that all air breathed passes through the mouthpiece, filter and flow head.

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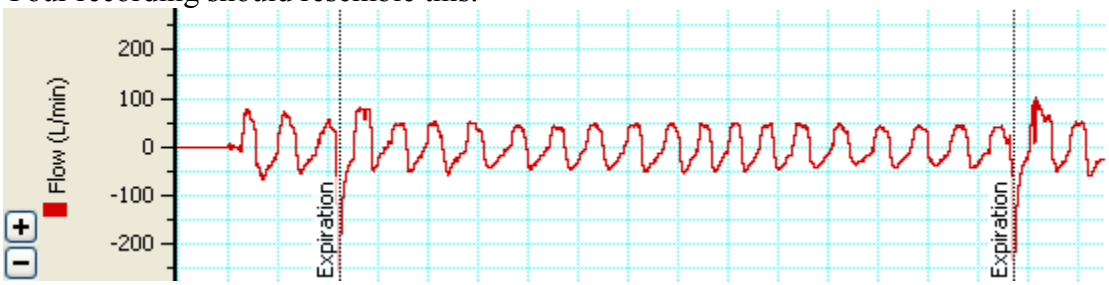
4. Observe the trace. The signal should show a downward deflection on expiration. If the signal deflects upward, stop recording and either reverse the orientation of the flow head, or swap the tubular connections to the Spirometer Pod.
5. When the volunteer has become accustomed to the apparatus and is breathing normally through it, stop recording and proceed to the next page.

Volume Correction

Expired air is greater in volume than inspired under most atmospheric conditions. This increase, due to warming and humidification, is typically 5-10%. For this reason it is necessary to apply a volume correction factor to the integration of flow.

Procedure

1. 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.
2. Click Start. Have the volunteer perform a full expiration through the flowhead and then breathe normally. Record the volunteers tidal breathing for one minute.
3. Add the comment "Volume correction procedure" to the data.
4. At the end of one minute, have the volunteer perform another full expiration. Click Stop. The volunteer can stop breathing through the flow head and remove the nose clip.
5. Your recording should resemble this.



Analysis

1. Select the entire recording of tidal breathing data, including the two forced expirations by double-clicking in the Time axis beneath the trace (this selects a block of data).
2. The default value for the volume correction

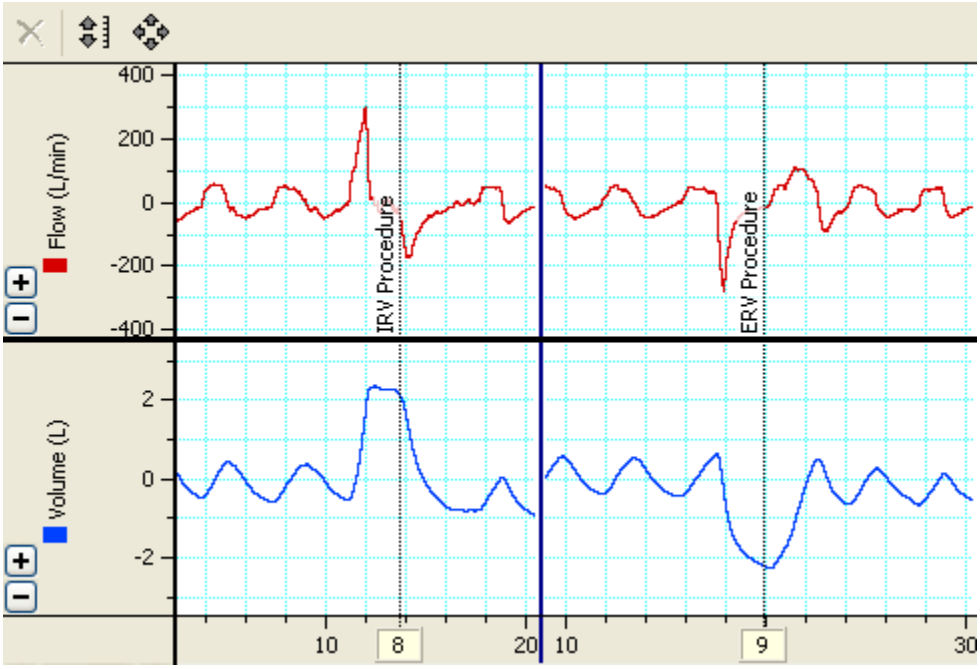
Exercise 1

In this exercise, you will examine the respiratory cycle and measure changes in volume.

It is important when recording normal respiration that the volunteer is not consciously controlling breathing. The volunteer should turn away from the computer screen and may have to stare out a window or read a book to distract themselves.

Procedure

1. 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.
2. Click Start. Ask the volunteer to replace the nose clip and breathe normally through the flow head. Record normal tidal breathing for at least 1 minute. Add the comment "Normal tidal breathing" to the data and stop recording.
3. Prepare a comment "IRV procedure", but do not click Add yet. Click Start and at the end of a normal tidal inspiration ask the volunteer toinhale as deeply as possible and then to breathe normally. Click Add and stop recording.
4. Prepare a comment "ERV procedure". Start recording and at the end of a normal tidal expiration ask the volunteer to exhale as deeply as possible and then to breathe normally. Click Add and stop recording.
5. The volunteer can stop breathing through the flow head and remove the nose clip.
6. Your recording should resemble this.



Analysis

Follow the steps below to complete the table.

For a reminder of the various lung volumes and capacities click here.

1. 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.
2. 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).

3. 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.
4. Repeat steps 2-3 to determine the Inspiratory Reserve Volume (IRV) and Expiratory Reserve Volume (ERV). The Marker should remain at the start of a normal tidal inspiration.
5. Click on this link and use the calculator to determine predicted values for Residual Volume (RV).
6. The Lung Capacities will be calculated by LabTutor for you.

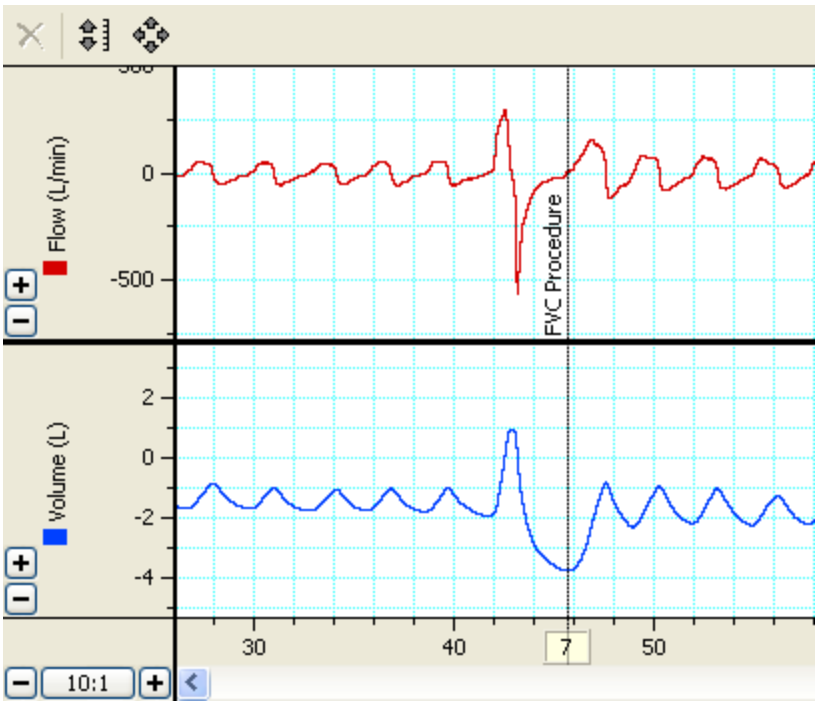
Exercise 2

In this exercise, you will measure parameters of forced expiration that are used in evaluating pulmonary function

You should use the same volunteer as for exercise 1.

Procedure

1. Re-zero the Spirometry Pod using the Zero Podbutton. Remember that the flow head must be left undisturbed on the bench during the zeroing process
2. Click Start.
3. Prepare a comment "FVC procedure".
4. Have the volunteer breathe normally for 30 seconds.
5. Ask the volunteer to inhale and then exhale as forcefully and fully as possible, until no more air can be expired. In the Comment box, click Add. After a few seconds, the volunteer should let his or her breathing return to normal.
6. Click Stop.
7. Your recording should resemble this.



8. Repeat steps 2-6 twice more, so that you have three separate forced vital capacity recordings

Analysis

Follow the steps below to complete the table. Click here for a reminder of the various lung volumes and capacities.

1. Using the Waveform Cursor and the Markertool as necessary, examine each of the three Forced Vital Capacity recordings (FVC).
2. On the Flow channel determine which of the three recordings shows a maximum Peak Inspiratory Flow (PIF).
3. Click to place this data in the Value panel. Drag this value into the appropriate cell in the table.
4. Repeat this step to determine the maximum Peak Expiratory Flow (PEF), and enter this into the table also.
5. On the Volume channel determine which of the three recordings shows a maximal FVC.
6. 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.
7. 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 (A time value anywhere from 0.96 to 1.04 s gives enough accuracy when using the cursor).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.

The ratio of FEV_1 to FVC expressed as a percentage, will be calculated by LabTutor for you.

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Exercise 3

The effects of bronchial restrictions such as asthma can be demonstrated by making the following modification to the equipment.

Setup

1. Remove the filter attachment from the clean-bore tubing.
2. Cover the end of the filter with duct tape.
3. Use a pen or a sharpened pencil to make a hole in the duct tape over the filter about a half centimeter in diameter.
4. Reattach the filter to the clean-bore tubing.

Procedure

Repeat the procedures in Exercise 2, as described below.

1. 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
2. Click Start.
3. Prepare a comment "FVC restricted".
4. Have the volunteer breathe normally for 30 seconds.
5. Have the volunteer **inhale** maximally and then **exhale** as forcefully and fully as possible, until no more air can be expired. In the Comment box, click Add. After a few seconds, the volunteer should let his or her breathing return to normal.
6. Click Stop.
7. Repeat steps 2-6 twice more, so that you have three separate forced vital capacity recordings.

Analysis

Repeat the analysis in Exercise 2, as described below.

1. Using the Waveform Cursor and the Markertool as necessary, examine each of the three Forced Vital Capacity recordings (FVC).
2. On the Flow channel determine which of the three recordings shows a maximum Peak Inspiratory Flow (PIF).
3. Click to place this data in the Value panel. Drag this value into the appropriate cell in the table.
4. Repeat this step to determine the maximum Peak Expiratory Flow (PEF), and enter this into the table also.
5. On the Volume channel determine which of the three recordings shows a maximal FVC.
6. 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.

7. 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 (A time value anywhere from 0.96 to 1.04 s gives enough accuracy when using the cursor).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.

The ratio of FEV_1 to FVC expressed as a percentage, will be calculated by LabTutor for you.

Exercise 4

In this exercise, you will compare the parameters of forced expiration measured in different volunteers.

Procedure

Repeat the procedures in Exercise 2, as described below, for up to three more volunteers.

⚠ Remember to replace the disposable filter and mouthpiece for each new volunteer.

1. 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
2. Click Start.
3. Prepare a comment "FVC volunteer 2".
4. Have the volunteer breathe normally for 30 seconds.
5. Have the volunteer **inhale** maximally and then **exhale** as forcefully and fully as possible, until no more air can be expired. In the Comment box, click Add. After a few seconds, the volunteer should let his or her breathing return to normal.
6. Click Stop.
7. Repeat steps 2-6 twice more, so that you have three separate forced vital capacity recordings.
8. Repeat steps 1-7 for each volunteer.

Analysis

Repeat the analysis in Exercise 2 and 3 for each volunteer, as described below.

1. Using the Waveform Cursor and the Marker tool as necessary, examine each of the three Forced Vital Capacity recordings (FVC).
2. On the Flow channel determine which of the three recordings shows a maximum Peak Inspiratory Flow (PIF).
3. Click to place this data in the Value panel. Drag this value into the appropriate cell in the table.
4. Repeat this step to determine the maximum Peak Expiratory Flow (PEF), and enter this into the table also.
5. On the Volume channel determine which of the three recordings shows a maximal FVC.

6. 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.
7. 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 (A time value anywhere from 0.96 to 1.04 s gives enough accuracy when using the cursor).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.

The ratio of FEV_1 to FVC expressed as a percentage, will be calculated by LabTutor for you.