

# Spirometer

(Order Code SPR-BTA)

The Spirometer can be used to perform a variety of experiments related to air flow and lung volume. The sensor handle can be held manually, or it can be attached to a tripod or stand using the threaded insert in the bottom of the handle. The sensor is composed of a removable Flow Head for easy cleaning and sterilization and a differential pressure transducer. The Spirometer can be used to perform a variety of tests, including:



- FEV (forced expiratory volume). FEV is the volume of air exhaled after a short period of constant effort. When this test is done over a one-second interval, it is known as FEV1.
- FVC (forced vital capacity). FVC is the volume of air exhaled by a forced maximal exhalation after a full inhalation.
- TV (tidal volume). TV is the volume of air inhaled and exhaled at rest.

## Inventory of Items Included with the Spirometer

Check to be sure that each of these items is included with your Spirometer:

- Spirometer (includes sensor handle and Flow Head)
- 5 disposable mouthpieces
- 1 disposable bacterial filter
- 2 nose clips

## Collecting Data with the Spirometer

This sensor can be used with the following interfaces to collect data:

- Vernier LabQuest<sup>®</sup> 2 or original LabQuest as a standalone device or with a computer
- Vernier LabPro<sup>®</sup> with a computer or TI graphing calculator
- Vernier Go!<sup>®</sup>Link
- Vernier EasyLink<sup>®</sup>
- Vernier SensorDAQ<sup>®</sup>
- CBL 2<sup>™</sup>
- TI-Nspire<sup>™</sup> Lab Cradle

Here is the general procedure to follow when using the Spirometer:

1. Connect the Spirometer to the interface.
2. Start the data-collection software.
3. The software will identify the Spirometer and load a default data-collection setup. You are now ready to collect data.

## Data-Collection Software

This sensor can be used with an interface and the following data-collection software.

- **Logger Pro** This computer program is used with LabQuest 2, LabQuest, LabPro, or Go!Link.
- **Logger Lite** This computer program is used with LabQuest 2, LabQuest, LabPro, or Go!Link.
- **LabQuest App** This program is used when LabQuest 2 or LabQuest is used as a stand-alone device (LabQuest App 1.2 or newer is recommended).
- **EasyData App** This calculator application for the TI-83 Plus and TI-84 Plus can be used with CBL 2, LabPro, and Vernier EasyLink. We recommend version 2.0 or newer, which can be downloaded from the Vernier web site, [www.vernier.com/easy/easydata.html](http://www.vernier.com/easy/easydata.html), and then transferred to the calculator. See the Vernier web site, [www.vernier.com/calc/software/index.html](http://www.vernier.com/calc/software/index.html) for more information on the App and Program Transfer Guidebook.
- **DataMate program** Use DataMate with LabPro or CBL 2 and TI-73, TI-83, TI-84, TI-86, TI-89, and Voyage 200 calculators. See the LabPro and CBL 2 Guidebooks for instructions on transferring DataMate to the calculator.
- **DataQuest™ Software for TI-Nspire™** This calculator application for the TI-Nspire can be used with the EasyLink or TI-Nspire Lab Cradle.
- **LabVIEW** National Instruments LabVIEW™ software is a graphical programming language sold by National Instruments. It is used with SensorDAQ and can be used with a number of other Vernier interfaces. See [www.vernier.com/labview](http://www.vernier.com/labview) for more information.

## Disassembling/Assembling the Spirometer

The Spirometer comes with a detachable Flow Head that can be removed for sterilization or replacement.

### Detaching the Flow Head from the Handle



*Push on the latches at the top of the handle until they splay outward.*



*Pull up on the Flow Head and remove it from the handle.*

## Attaching the Flow Head to the Handle



*Push in the two latches at the top of the handle so that they splay outward*



*Line up the two small holes on the base of the Flow Head with the two ports inside the top of the handle*



*Press down firmly on the Flow Head until it securely attaches to the handle. Push the latches in to lock the Flow Head in place*

## Using the Spirometer

The Spirometer can be used for both expiratory only and inspiratory /expiratory experiments. Use the following combinations of mouthpieces, filters, and Flow Heads for the type of experiment you are doing.

### Expiratory Only

Use a disposable cardboard mouthpiece with the Spirometer for experiments in which the students will only exhale through the Spirometer. Attach the mouthpiece to the side of the Flow Head marked “Inlet.”



### Inspiratory/Expiratory

Use a disposable cardboard mouthpiece and a disposable bacterial filter with the Spirometer for experiments in which the students inhale and exhale through the Spirometer. Attach the bacterial filter to the side of the Flow Head marked “Inlet” and attach the cardboard mouthpiece to the bacterial filter.

In an ideal situation, every student would have his or her own bacterial filter and disposable mouthpiece. According to the manufacturer’s specs, the MicroGard<sup>®</sup> filters out more than 99% of bacterial and viral aerosols.



## Cleaning the Flow Head

The manufacturer recommends three methods, in the following order, with which to sterilize the Flow Head.

1. Wash the detachable Flow Head in a dishwasher. It is dishwasher safe. This method provides the longest life for the Flow Head and is the method most recommended by the manufacturer.
2. Cold sterilize the Flow Head with a surface disinfectant such as Cidex<sup>®</sup> or Technical Tincture of Green Soap<sup>®</sup>. These are available from medical supply or janitorial supply companies.
3. Autoclave the Flow Head. This method provides the shortest life span for the Flow Head.

We recommend that you sterilize the Flow Head using one of these methods after each school day, at the very least, and that you always use the Spirometer with a disposable mouthpiece.

The nose clips should be wiped clean between uses and soaked in a mild detergent after each experiment.

## Taking Measurements with the Spirometer

- Ensure that the person being tested is breathing only through his/her mouth. The person can use a nose clip or hold his/her nose.
- Connect a disposable bacterial filter and a disposable mouthpiece to the clear plastic Flow Head on the side labeled “Inlet”.
- Hold the Spirometer vertically and still during use.
- For best results, start the data collection on an exhale.

**Note:** Vernier products are designed for educational use. Our products are not designed nor recommended for any industrial, medical, or commercial process such as life support, patient diagnosis, control of a manufacturing process, or industrial testing of any kind.

## Specifications

Flow rate	$\pm 10$ L/s
Dead space	93 mL
Nominal output	128 mV/[L/s]
Detachable flow head	
Dimensions	80.5 mm (diameter) $\times$ 101.5 mm (length)
Mass	80 g
Construction	clear acrylic plastic
Handle	
Dimensions	127 mm $\times$ 23 mm $\times$ 35 mm
Mass	85 g
Construction	black ABS plastic
Cable length	1.5 meters
Stored calibration	
	Slope 7.8 (L/s)/V
	Intercept $-17.55$ L/s

This sensor is equipped with circuitry that supports auto-ID. When used with LabQuest 2, LabQuest, LabQuest Mini, LabPro, Go! Link, SensorDAQ, TI-Nspire Lab Cradle, EasyLink, or CBL 2, the data-collection software identifies the sensor and uses pre-defined parameters to configure an experiment appropriate to the recognized sensor.

## How the Spirometer Works

When the Spirometer is assembled, a subject blows into a Flow Head composed of a plastic housing through which air is forced. In the center of the Flow Head is a mesh screen. As air is forced through the Flow Head a slight difference in pressure occurs between the front and the back surface of the screen. A tube in front of the screen and a tube behind the screen pass the pressures to a differential pressure transducer. The greater the airflow passing through the screen, the greater the pressure differential. This allows for the direct measurement of airflow rate (L/s). Volume (L) is calculated by integrating the flow rate (L/s) as a function of time (s).

## Calibration Information

You should not have to perform a new calibration when using the Spirometer. We have set the sensor to match our stored calibration before shipping it. You can simply use the appropriate calibration value that is stored in the data-collection program.

## Spirometer Accessories

The following items are available for the Spirometer.

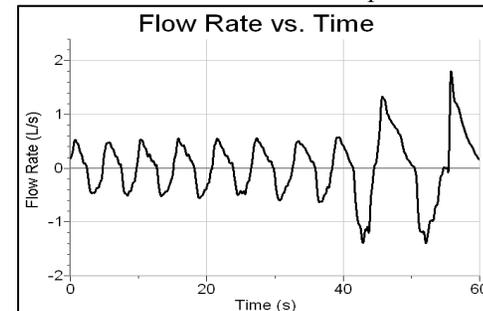
- Disposable Bacterial Filter (pkg. of 10) order code SPR-FIL
- Disposable Mouthpiece (pkg. of 30) order code SPR-MP
- Noseclip (pkg. of 10) order code SPR-NOSE
- Spirometer Flow Head order code SPR-FLOW

## Using the Spirometer in Your Classroom

Here are a few examples of experiments that can be conducted with the Spirometer.

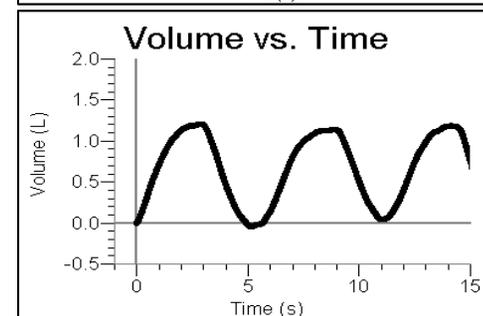
### Breathing Patterns

A student's normal, resting breathing pattern is measured by a Spirometer. A graph of the data shows the student breathing in (inspiration) and breathing out (expiration). The graph shows typical results of the flow rate during a normal breath and a deep breath.



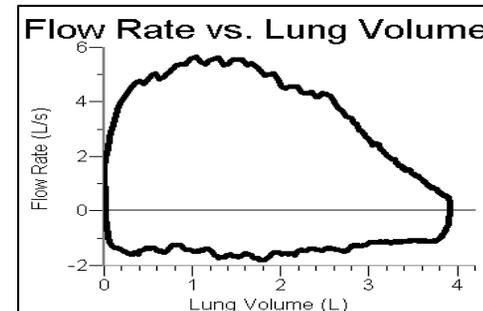
### Tidal Volume

A student's normal, resting breathing pattern is measured. A graph of the data shows the volume of air the student breathes in (inspiration) and breathes out (expiration). The overall process is referred to as *ventilation*. *Tidal volume* is the amount of air that a person breathes in with a normal breath.



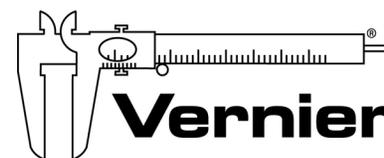
### Forced Vital Capacity (FVC)

In this activity, the student exhales forcefully and very quickly into the Spirometer, and then inhales. The graph of this event, shown here, allows the student to determine his/her forced vital capacity. The graph is a plot of lung volume (*x*-axis) vs. flow rate (*y*-axis). The data may also be examined to determine Forced Expiratory Volume after 1 second (FEV<sub>1</sub>).



## Warranty

Vernier warrants this product to be free from defects in materials and workmanship for a period of five years from the date of shipment to the customer. The replaceable Flow Head, manufactured by BIOPAC Systems, Inc., carries the warranty provided by them (12 months) and is not subject to a separate warranty by Vernier. This warranty does not cover damage to the product caused by abuse or improper use.



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