Respiration Monitor Belt

(Order Code RMB)

The Respiration Monitor Belt is used to measure human respiration rates. It must be attached to the Vernier Gas Pressure Sensor or Biology Gas Pressure Sensor (see Figure 1), which is then connected to any of the Vernier interfaces (Vernier LabPro®, Go!® Link, ULI, or Serial Box Interface), as well as the Texas Instruments CBL™ or CBL 2™. The following are some of the activities and experiments that can be performed using the Respiration Monitor Belt:

- Study the resting respiration pattern of students.
- Investigate respiration patterns that have been interrupted by simple activities such as holding of breath or drinking a beverage.
- Compare respiration rates of athletes and non-athletes.
- Compare respiration rates of females and males.
- Monitor respiration rates, including recovery time, before and after vigorous exercise.
- Monitor respiration rates before and after drinking of caffeinated beverages.
- Measure the effect of increased levels of carbon dioxide gas on respiration rate.
- Compare respiration rate and heart rate (using a Vernier Heart Rate Monitor). Students can compare the effect of exercise, body types, food or drink consumption, or carbon dioxide levels on these two rates.

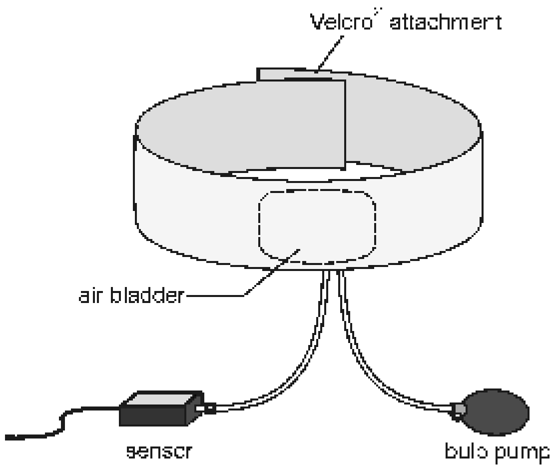


Figure 1

Keep in mind that used alone, the Gas Pressure Sensor or Biology Gas Pressure Sensor has many other uses in biology experiments. Activities for the Gas Pressure Sensor and Biology Gas Pressure Sensor are summarized in the sensor booklet that is included with each sensor. Some of these activities include:

- Monitor the production of O_2 during photosynthesis of an aquatic plant in a closed system.
- Determine the rate of transpiration for a plant under different conditions.
- Determine the rate of respiration in germinating pea or bean seeds.
- Study the effect of temperature and concentration on the rate of decomposition of H_2O_2.
- Determine the effect of temperature on cold-blooded organisms by monitoring their respiration.
- Monitor barometric pressure associated with weather phenomena.

NOTE: This product is to be used for educational purposes only. It is not appropriate for industrial, medical, research, or commercial applications. Specifically, it may not be used for patient diagnosis.

How to Use the Respiration Monitor Belt

Follow this procedure to make measurements with the Respiration Monitor Belt connected to a Gas Pressure Sensor and a Vernier interface or TI CBL System:

1. If you are collecting data with a computer, run Logger *Pro*®, open an experiment file set up for the Respiration Monitor Belt. If you are collecting data with a calculator, run the DataMate or Chembio program and select a Respiration sensor.
2. If the Gas Pressure Sensor you are using has a blue plastic valve on it, place the valve in the position shown in Figure 2. If there is no valve, proceed to Step 3.

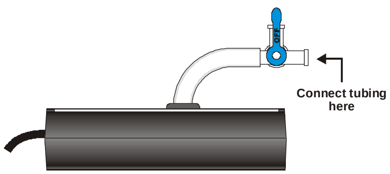


Figure 2

3. Select one member of the group as the test subject. Wrap the Respiration Monitor Belt snugly around the test subject's chest. Press the Velcro strips together at the back. Position the belt on the test subject so that the belt's air bladder is resting over the base of the rib cage and in alignment with the elbows as shown in Figure 3.

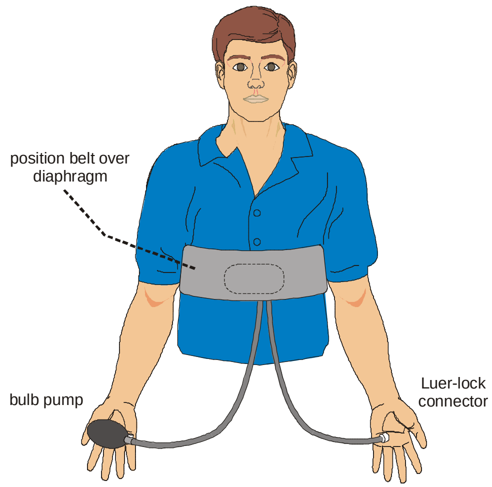


Figure 3

4. Attach the Respiration Monitor Belt to the Gas Pressure Sensor. There are two rubber tubes connected to the bladder. One tube has a white Luer-lock connector at the end and the other tube has a bulb pump attached. Connect the Luer-lock connector to the stem on the Gas Pressure Sensor with a gentle half turn.
5. Have the test subject sit upright in a chair. Close the shut-off screw of the bulb pump by turning it clockwise as far as it will go. Pump air into the bladder by squeezing on the bulb pump. Fill the bladder as full as possible without causing discomfort for the test subject.
6. The pressure reading displayed in the meter should increase about 6 kPa above the initial pressure reading (e.g., at sea level, the pressure would increase from about 100 to 106 kPa). At this pressure, the belt and bladder should press firmly against the test subject's diaphragm. Pressures will vary, depending upon how tightly the belt was initially wrapped around the test subject.
7. As the test subject breathes in and out normally, the displayed pressure alternately increases and decreases over a range of about 2–3 kPa. If the range is less than 1 kPa, it may be necessary to pump more air into the bladder. **Note**: If you still do not have an adequate range, you may need to tighten the belt.

   Once normal breathing of the test subject results in pressure changes of 2-3 kPa or more, you are ready to begin doing an experiment.

Setting up the Computer or CBL System to Monitor Respiration

Here are some suggestions for setting up your computer or CBL to take data using the Respiration Monitor Belt with a Biology Gas Pressure Sensor:

- With a Vernier computer data-collection program, simply load an experiment file for the Respiration Monitor Belt.
- When using the LabPro or CBL 2 with a TI graphing calculator, select RESPIRATION from the SELECT SENSOR menu. From the main screen, select START to begin collecting respiration rate data.
- When using the CBL and a TI graphing calculator using the CHEMBIO program, select Respiration Monitor from the Select Probe menu. Then select Time Graph from the Data Collection menu, and set up the CBL to take a total of 90 readings, one reading every 0.5 seconds. The total length of the data collection will be 45 seconds.

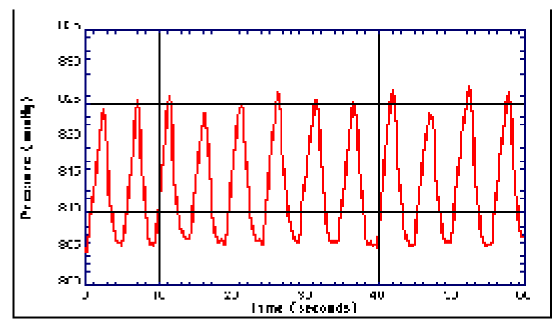
Calibration

You should never have to perform a new calibration for the Respiration Monitor Belt using the Gas Pressure Sensor. Any experiments we describe in this booklet or in the *Biology with Computers* and *Biology with Calculators* lab manuals will use a stored Vernier calibration.

Suggested Experiments

Monitoring Human Respiratory Patterns

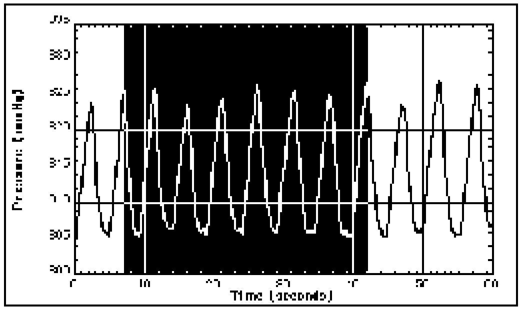
You can study respiratory patterns and examine how certain stimuli and conditions affect those patterns. First, set up an experiment as described in the previous two sections. It is very important that the test subject be positioned so he or she cannot directly view the computer or calculator screen. Once the test subject is breathing in a relaxed manner, begin collecting data. This graph displays a typical resting respiratory pattern using the Respiration Monitor Belt with a Gas Pressure Sensor.



You may want to examine the data to determine either *respiration rate* or the *respiration period*. Using the Examine or Analyze features of the Vernier data-collection programs (or Trace on a TI calculator), you can examine a portion of the data from the peak of one respiration cycle to the peak of another. In the graph below, the darkened segment of the data is selected so that the time between two peaks can be determined from Statistics. Using the time between the 2nd and 9th peaks (42.00 s – 7.07 s = 34.93 s), the respiration rate or respiration period can be calculated:

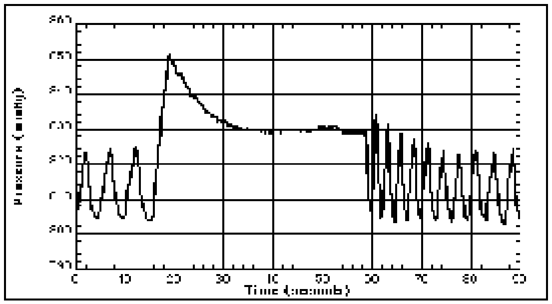
Respiration rate = 7 breaths / 34.93 s = 0.200 breaths/s = 12.0 breaths/min

Respiration period = 34.93 s / 7 breaths = 4.99 s/breath



Respiration Interrupted by Holding of Breath

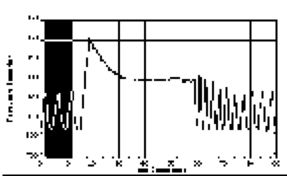
In this exercise, the test subject is instructed to breathe in a relaxed manner, hold his or her breath after about 20 seconds, then resume breathing after about one minute (40 additional seconds). Data collected in this manner is shown here:

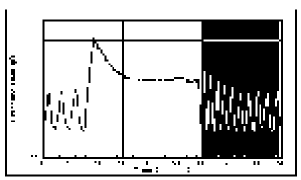


Now determine the respiration period (or respiration rate), as described in the previous section. Select data in the regions prior to and following the holding of breath, as shown in the following graphs. Then calculate the respiration period for each:

Before holding of breath: 10.60 s / 2 breaths = 5.30 s/breath

After holding of breath: 27.44 s / 9 breaths = 3.05 s/breath





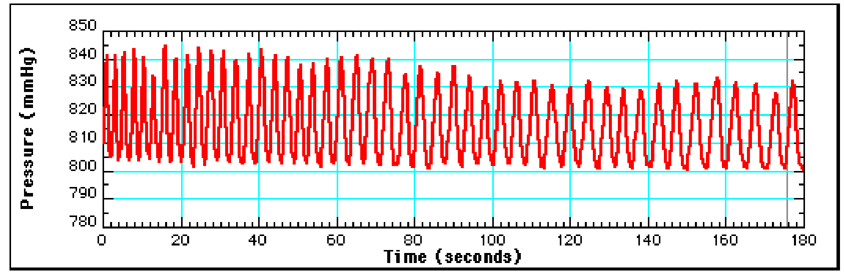
Students can easily observe the decrease in respiration period (or increase in respiration rate) due to holding breath. Students can also investigate the recovery of respiration rate—the respiration period increased from 2.50 to 3.76 s/breath between 60 and 90 seconds in the data shown here.

Recovery of Respiration Rate after Vigorous Exercise

To investigate the effect of vigorous exercise on respiration rate, have the test subject jog in place for 2 minutes. Afterward, collect respiration data for 3 minutes, and analyze the data to see how the respiration rate changes. In the sample data shown in the graph below (*after* exercise), the following respiration rates were obtained at the beginning and end of data collection:

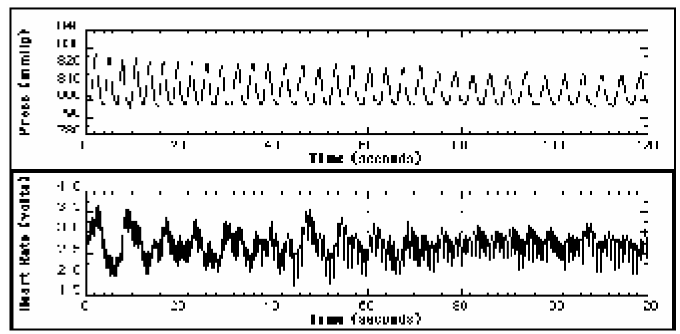
5 breaths (after exercising): 5 breaths / 12.48 s = 0.401 breaths/s = 24.0 breaths/min

5 breaths (after recovery): 5 breaths / 24.95 s = 0.200 breaths/s = 12.0 breaths/min

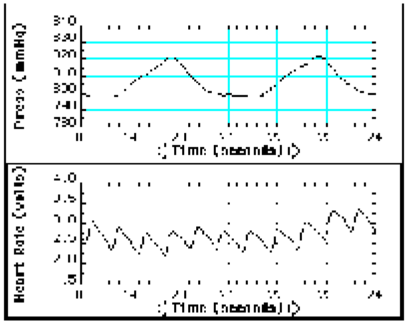
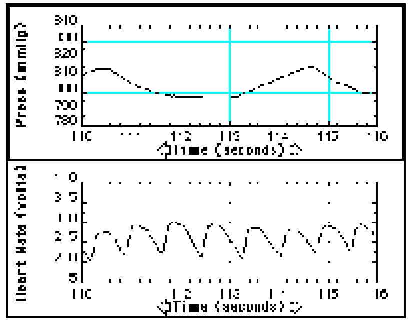


Comparing Respiration Rate and Heart Rate after Jogging

It is interesting to compare respiration rates with heart rates (measured with the Vernier Heart Rate Monitor). The following data were collected with a Respiration Monitor Belt and Gas Pressure Sensor connected to Port 1 of a Serial Box Interface and a Heart Rate Monitor connected to Port 2. The data-collection rate is set at 50 readings/s. The data shown here were collected after the test subject jogged in place for two minutes.



Because the heart-rate readings occur at a much higher rate than respiration rate, we have zoomed in to examine the data between 18 and 24 seconds (left-hand graphs below) and between 110 and 116 seconds (right-hand graphs).

By comparing the respiration rate and heart rate at these two times, recovery rate can be investigated:

Respiration rate after exercise:	0.334 breaths/s = 20.0 breaths/min
Heart rate after exercise:	1.83 beats/s = 110 beats/min
Respiration rate after recovery:	0.236 breaths/s = 14.2 breaths/min
Heart rate after recovery:	1.33 beats/s = 79.8 beats/min

As can be seen from the calculations, both reparation rate and heart rate made a significant recovery in the two-minute time period over which data were collected—respiration rate improved from 20.0 to 14.2 breaths/min, or by 29.0%, and heart rate from 110 to 79.8 beats/min, or by 27.5%.

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