Can You Take the Pressure?

6984

INTRODUCTION

Gases behave differently depending on how much pressure is exerted upon them. By changing the amount of pressure on a given amount of a gas, students can begin exploring how the concepts of gas pressure and volume are connected.

Activity Overview

In this activity we will

- use the Vernier EasyLink™ and the Gas Pressure Sensor
- determine the volume of a gas in a container under different pressures
- graph pressure/volume data
- interpret the graphs

Approximate Total Time: 35 minutes

Science Objective

The Vernier Gas Pressure Sensor helps students to understand the relationship between pressure and volume of a confined gas at a constant temperature.

PROCEDURE (IN PAIRS)

1

Plug the Gas Pressure Sensor into the USB port on the EasyLink. Plug the EasyLink into the calculator. Your calculator will turn on, the EasyData App will load automatically, and GAS PRESSURE (KPA) will be displayed on the screen.

2

In the box for the Gas Pressure Sensor, you will find a syringe. Move the plunger of the syringe until the volume reading is 5.0 mL. Attach the syringe to the white stem end of the sensor, with a *gentle* half turn.

3

The gas pressure reading should be about 101 kPa.

4

Press WINDOW to select SETUP. Press 3 to select EVENTS WITH ENTRY.

5

You are now ready to collect pressure/volume data. It is best for one person to handle the gas syringe and for another to operate the calculator.

6

Press ZOOM to select START to begin collecting data. If you get a message about overwriting stored data, select OK. When the pressure readings are constant, press WINDOW to select KEEP. In the ENTER VALUE screen, enter 5.8. This is the 5.0 mL in the syringe plus 0.8 mL in the system. You will need to add 0.8 to each syringe value: 5.0, 7.5, 10.0, 12.5, 15.0, 17.5, and 20.0 mL.

7

After entering 5.8, press GRAPH for OK. You will see the same screen you saw after selecting START. With the syringe still attached to the Gas Pressure Sensor, pull the plunger of the syringe until it reads 7.5 mL. When the pressure reading is constant, select KEEP and enter 8.3 (this is 7.5 + 0.8). Select OK. Repeat this procedure until all pressure/volumes have been entered.

Can You Take the Pressure?

8

After all pressure/volumes have been entered, press ⌷ZOOM⌷ to select STOP.
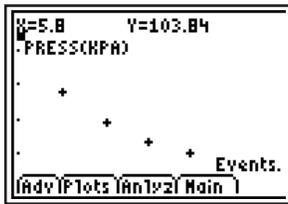
9

Press ⌷ZOOM⌷ to select ANLYZ, then press ⌷4⌷ to select POWER FIT. Round off the first three digits of **a** and the first three digits of **b**. Write these values in the bottom row of the data table. Select OK.
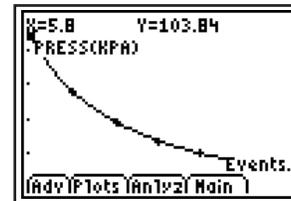
10

Use the arrow keys to highlight your data points. In the example above, the first data point is 5.8 mL, 100.9 kPa. Record your data points in the data table.

11

Select MAIN, then select QUIT, and then select OK.

DATA TABLE

Volume (mL)	Pressure (kPa)	a value	b value	Pressure × volume (kPa•mL)

Equation for Power Fit is $y = ax^b$ (shown on the screen as $y = ax\text{\textasciicircum}b$), where y is pressure and x is volume; **a** and **b** are constants.

DATA ANALYSIS

1. What two experimental factors are assumed to be constant in this experiment?
2. As the volume of the gas in the syringe increases, what happens to its pressure? Does this mean a direct or inverse relationship exists between the pressure and volume of the gas?
3. Explain how your graph shows this relationship.
4. Using the equation for Power Fit, calculate the pressure for a volume of 16.6 mL. How does this pressure compare with the pressure for 8.3 mL of the gas?
5. Using the equation for Power Fit, calculate the pressure for a volume of 7.9 mL. How does this pressure compare with the pressure for 15.3 mL of the gas?
6. Complete the last column in the data table. Record all results to the correct number of significant figures.
7. How constant are the values of pressure × volume? Good data may show some minor variation, but the values for pressure × volume should be relatively constant.
8. Explain how your answer to the last question agrees with Boyle's law: $P_1 \times V_1 = P_2 \times V_2$ for a confined gas at constant temperature.

TI-NAVIGATOR™ SYSTEM EXTENSION

For each pair of students, instruct one student to follow the procedure with their calculator. Instruct the other student to be prepared to answer Quick Poll questions with their calculator. Questions may include:

After Step 5:	Do you expect the pressure to increase or decrease by the end of this experiment?
During Step 7:	Was your initial assumption correct or incorrect based on the data you are gathering?

Refer to **Appendix C** for details on using the Quick Poll feature of the TI-Navigator™ System.