Boyle's Law
Student Activity

Name _______________
Class _______________

Boyle's Law is a basic law in science developed in 1662 by Robert Boyle, an Anglo-Irish scientist. Boyle is considered the father of modern Chemistry. He studied the relationship between gas volume and pressure. In this experiment you will gather data to learn of the relationship between pressure and volume of a gas.

OBJECTIVES

- Use a Gas Pressure Sensor and a gas syringe to measure the pressure of an air sample at several different volumes.
- Determine the relationship between pressure and volume of the gas.
- Describe the relationship between gas pressure and volume in a mathematical equation.
- Use the results to predict the pressure at other volumes.

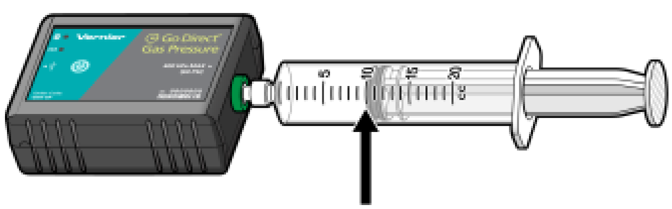

Figure 1.

MATERIALS

- TI-Nspire™ CX II
- Calculator Connection Cable (Mini-A to Micro-B USB)
- GDX Gas Pressure
- 20 mL gas syringe

PROCEDURE

1. Make a data table on a separate sheet of paper to record six pressure volume pairs and two extra columns for PV and P/V.

2. Turn on the TI-Nspire CX II.

3. Connect the GDX Gas Pressure Sensor to the TI-spire CX II Handheld with the cable provided. The Vernier DataQuest App will automatically open.

4. With the 20 mL syringe disconnected from the Gas Pressure Sensor, move the piston of the syringe until the front edge of the inside black ring (indicated by the arrow in Figure 1) is positioned at the 10.0 mL mark.

5. Attach the 20 mL syringe to the valve of the Gas Pressure Sensor securely, but do NOT overtighten.

6. Click [Mode] to open Data Collection Settings. Change the Mode to Events with Entry and press

OK.

7. Click on Event Name and enter **Volume** as the Event Name and **mL** as the Units. Click OK.

8. To account for the extra volume in sensor, you will need to add 0.8 mL to your syringe readings. For example, with a 5.0 mL syringe volume, the total volume would be 5.8 mL.

9. You are now ready to collect pressure and volume data. It is easiest if one person takes care of the gas syringe and another enters volumes.

10. Click the ( ).to start data collection.

11. Move the piston so the front edge of the inside black ring (see Figure 2) is positioned at the 5.0 mL line on the syringe. Hold the piston firmly in this position until the pressure value displayed on the screen stabilizes.

12. Click the camera icon ( ) to keep the value and enter **5.8**, the gas volume (in mL). Remember, you are adding 0.8 mL to the volume of the syringe for the total volume. Click OK to store this pressure-volume data pair.

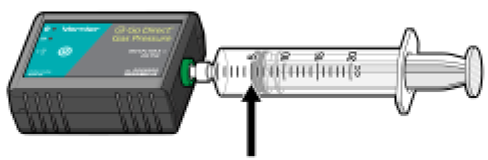

Figure 2

13. Continue this procedure using syringe volumes of 10.0, 12.5, 15.0, 17.5, and 20.0 mL.

14. Click the ( ) to stop data collection.

15. The graph of pressure *vs*. volume is now displayed. To examine the data pairs on the displayed graph, click any data point. As you click each data point, the pressure and volume values are displayed to the left of the graph.

16. Click the table icon ( ) on the lower left of the screen to see the data table. Record the data in the data table you prepared earlier.

17. Click [Menu] on the TI-Nspire, choose Analyze, Curve Fit, Power ($ax^{\wedge b}$).

18. The statistics for the graph will be shown. Record the values for (a), (b), and (r) on the data table that you created.

19. Click OK to see the graph and its Power Regression. The curve should nicely fit the data points.

Name _______________
Class _______________

DATA ANALYSIS

1. Choose [doc] on the TI-Nspire, Insert, and choose Lists & Spreadsheet.

2. Move the cursor to the right of the A in the table.

3. Choose [var] Link To:, and choose run1.vol. The volume data will be displayed in the table.

4. Move the cursor to the right of B in the table.

5. Choose [var], Link To:, and choose run1.pressure. The pressure data will be displayed.

6. Move to the right of C and type in pv.

7. Move the cursor down to the equals (=) row. Choose (=), and choose [var], Link To:, run1.pressure, times key, [var], Link To:, run1.vol. Press [enter]. The product of pressure and volume will be displayed.

8. Record the product in your data table.

9. Move to the right of D and type in pdivv.

10. Move the cursor down to the equals (=) row and choose [var,] Link To:, run1.pressure, divide key, [var], Link To:, run1.vol. Press [enter]. The quotient of pressure divided by volume will be displayed.

11. Record the quotient in your data table.

12. Remember we used a Power Regression ($ax^{\wedge b}$). Compare the (a)value from the Power Regression data that you recorded in you data table. Is the P times V product or the P divided by V quotient closest to the value of (a) from the regression?

13. From what you learned in step 12, is Boyle's Law $k = P/V$ or $k = P \bullet V$? Explain.

QUESTIONS

1. What happens to the pressure when the volume is *doubled*? Show the pressure values in your answer.

2. What occurs to the pressure if the volume is *halved* from 20.0 mL to 10.0 mL? Show the pressure values in your answer.

3. How is the pressure changed when the volume is *tripled* from 5.0 mL to 15.0 mL? Show the pressure values in your answer.

4. From your data, do you think the relationship between the pressure and volume of a confined gas is direct or inverse? Explain your answer.

5. Based on your data, what would you expect the pressure to be if the volume of the syringe was increased from 10.0 mL to 40.0 mL? Explain or show work to support your answer.

6. Based on your data, what would you expect the pressure to be if the volume of the syringe was decreased from 10.0 mL to 2.5 mL? Explain or show work to support your answer.

7. What experimental factors are assumed to be constant in this experiment?

8. Which of these results in a more constant k value: $k = P/V$ *or* $k = P \bullet V$? Explain your answer.