**Lab #52: Pressure and Volume Relationship in Gases- Boyle’s Law**

*Materials*

* Pressure/Volume Sensor
* Labquest
* Computer

**Part 1: Pre-Lab**

\*Annotate the following information\*

 Historically, this relationship was first established by Robert Boyle in 1662 and has since been known as Boyle’s law. The primary objective of this experiment is to determine the relationship between the pressure and volume of a confined gas. The gas we use will be air, and it will be confined in a syringe connected to a Gas Pressure Sensor (see Figure 1). When the volume of the syringe is changed by moving the piston, a change occurs in the pressure exerted by the confined gas. This pressure change will be monitored using a Gas Pressure Sensor. It is assumed that temperature will be constant throughout the experiment. Pressure and volume data pairs will be collected during this experiment and then analyzed. From the data and graph, you should be able to determine what kind of mathematical relationship exists between the pressure and volume of the confined gas. Once we have this data we can use a known pressure or volume to find the other variable.

**Part 2: Pre-Lab Questions**

1. What does the term confined mean?
2. Who created this gas law?
3. What is the purpose of this lab?

**Part 3: Procedure**

1. Prepare the Gas Pressure Sensor and an air sample for data collection.
2. Plug the Gas Pressure Sensor into Channel 1 of the computer interface.
3. 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 10.0mL mark.
4. Attach the 20 mL syringe to the valve of the Gas Pressure Sensor.
5. Collect the pressure *vs.* volume data. It is best for one person to take care of the gas syringe and for another to operate the computer.
6. Move the piston to position the front edge of the inside black ring (see Figure 2) at the
5.0 mL line on the syringe. Hold the piston firmly in this position until the pressure value stabilizes.



Figure 1 Figure 2

1. When the pressure reading has stabilized, record the value in the data table.
2. Repeat, moving the piston to different volumes until you have collected all of the data points.

DATA and calculations

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| --- | --- | --- |
| Volume(mL) | Pressure(kPa) | Constant, *k*(*P / V* or *P • V*)You will circle which equation to use |
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1. In your data table, record the pressure and volume data pairs displayed in the table. Examine the graph of pressure *vs.* volume. Based on this graph, decide what kind of mathematical relationship you think exists between these two variables, direct or inverse.
2. One way to determine if a relationship is inverse or direct is to find a proportionality constant, *k*, from the data. If this relationship is direct, *k* = *P/V*. If it is inverse, *k* = *P****•****V*. Based on your answer to Question 4, choose one of these formulas and calculate k for the seven ordered pairs in your data table (divide or multiply the *P* and *V* values). Show the answers in the third column of the Data and Calculations table.
3. How *constant* were the values for *k* you obtained in Question 2? Good data may show some minor variation, but the values for *k* should be relatively constant.
4. Using *P, V*, and *k*, write an equation representing Boyle’s law. Write a verbal statement that correctly expresses Boyle’s law.



**Part 4: Procedure**

1. Graph your data. You may do this on the graph to the right or you may complete this graph on excel and email it to Mrs. Cheek and your lab partners. Be sure to label your axis!
2. Draw a best-fit curve line.
3. What is the pressure at a volume of 5.0 mL? What if the value is doubled to a volume doubled (10.0 mL). What does your data show happens to the pressure when the volume is *doubled*? Show the pressure values in your answer.
4. Using the same technique as in Question 2, what does your data show happens to the pressure if the volume is *halved* from 20.0 mL to 10.0 mL? Show the pressure values in your answer.
5. Using the graph, what does your data show happens to the pressure if the volume is *tripled* from 5.0 mL to 15.0 mL? Show the pressure values in your answer.
6. From the shape of the curve in the plot of pressure *vs.* volume, do you think the relationship between the pressure and volume of a confined gas is direct or inverse? Explain your answer.
7. Based on your data, what would you expect the pressure to be if the volume of the syringe was increased to 40.0 mL? Explain or show work to support your answer.
8. Based on your data, what would you expect the pressure to be if the volume of the syringe was decreased to 2.5 mL? Explain or show work to support your answer.