Exploring the Properties of Gases

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. Historically, this relationship was first established by Robert Boyle in 1662 and has since been known as Boyle’s law.

You will also you will study the relationship between the number of particles in a gas sample and the pressure it exerts.

Processing the data

1. If the volume is *doubled* from 5.0 mL to 10.0 mL, what does your data show happens to the pressure? Show the pressure values in your answer.

2. If the volume is *halved* from 20.0 mL to 10.0 mL, what does your data show happens to the pressure? Show the pressure values in your answer.

3. If the volume is *tripled* from 5.0 mL to 15.0 mL, what does your data show happened to the pressure? Show the pressure values in your answer.

4. From your answers to the first three questions *and* the shape of the curve in the plot of pressure versus volume, 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 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 to 2.5 mL.

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

8. 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.

9. How *constant* were the values for *k* you obtained in Question 8? Good data may show some minor variation, but the values for *k* should be relatively constant.

10. Using *P*, *V*, and *k*, write an equation representing Boyle’s law relating the relationship of pressure to volume. Write a verbal statement that correctly expresses Boyle’s law.

11. State that the pressure is directly proportional to the number of particles.

12. What happens to the number of particles if pressure is doubled?

12. What happens to the pressure if the amount of particles is halved?

13. From your answers to the questions above *and* the shape of the curve in the plot of pressure versus number of puffs, do you think the relationship between the pressure and number of particles for a gas is direct or inverse? Explain your answer.

14. Using *P*, *n*, and *k*, write an equation representing the relationship of pressure to number of particles. Write a verbal statement that correctly the relationship of number of particles to pressure.