Pressure Sensor

Experiment Guide

Pressure Sensor

Introduction:

Part of the Eisco series of hand held sensors, the pressure sensor allows students to record and graph data in experiments on the go.

This sensor can be used to monitor chemical reactions that involve gases and to investigate both Boyle's Law and the Gay-Lussac's Law for ideal gases. It can also prove useful in studies of weather phenomena and yeast fermentation.

The pressure sensor is located in a plastic box. The sensing part is connected to a plastic tube for connection to pressure sources such as a syringe via an adapter.

Sensor Specs:

Range 0 - 7 atm | 0.01 atm resolution | 100 max sample rate
Range 0 - 100 psi | 0.1 psi resolution | 100 max sample rate
Range 0 - 700 kPa | 0.1 kPa resolution | 100 max sample rate
Range 0 - 7 bar | 0.01 bar resolution | 100 max sample rate

Activity – Boyle's Law

General Background:

Discovered by chemist Robert Boyle in 1662, there exists a fundamental relationship between the pressure exerted by a gas of given mass and the volume of that gas. Boyle found that the pressure of a gas tends to increase as the volume of the gas decreases. We describe this relationship as the pressure being inversely proportional to the volume, and this holds true as long as the temperature and amount of gas remain fixed.

We can write this inversely proportional relationship as an equation:

$$P \propto {}^{1}/_{V}$$

or, alternatively, that the product of the pressure of the gas, P with the volume of the gas, V, is a constant, k. Or

$$PV = k.$$

In this activity, we will be comparing the pressure and volume of a given amount of air that is contained inside a syringe under different amounts of compression of the plunger. We will discover that since Boyle's law holds true in this case, the pressure and volume for any amount of compression will remain equivalent. Or written in equation form

$$P_1V_1 = P_2V_2 = P_3V_3 = P_4V_4,$$

where the numerical subscripts denote different amounts of syringe compression.

Required Materials:

Eisco Pressure Sensor & Handheld Unit
Eisco Boyle's Law Apparatus – Simple Form [PH0145A]
5 cm of rubber tubing, with inner diameter 3mm.

Experiment

1. Remove the syringe from the Boyle's Law apparatus. Pull the plunger of the syringe back to so the front edge of the piston is at the 40 mL mark.
2. Insert one end of the rubber tube into the end of the syringe. Insert the other end into the Eisco Pressure Sensor as shown in the figure to the right.
3. Set the Eisco Pressure Sensor to record in kPa (kilopascals).
4. Record the pressure for a 40 mL syringe volume in the table. For the actual volume, one must also account for the air in the rubber tube and in the pressure sensor itself, so add 0.5 mL to the volume measurement to give a better approximation for the total volume in the system.
5. Push in the plunger on the syringe, compressing the air a total of 4 mL. Hold it at that mark while taking a reading of the pressure. Record in the table, remembering to add 0.5 mL to the volume reading.
6. Continue taking readings for pressure with respect to volume for 4 mL additional compression. Hold the syringe at the mark while taking a reading. Compress to 20 mL or until it is too difficult to compress the plunger any further.

Data

Volume (mL)	Pressure (kPa)	P * V (mL*kPa)

Data Analysis

1. Multiply the pressure times the volume for each measurement. Record in the third column of the table.
2. Do you find that the product of volume and pressure are equivalent under compression of the air? Average the six products and then determine which is the measurement has the largest difference from the average. What is the percent difference between the biggest result and the average result?

Sample Results

Volume (mL)	Pressure (kPa)	P * V (mL*kPa)
40.5	101.8	4122.9
36.5	112.2	4095.3
32.5	124.3	4039.8
28.5	140	3990.0
24.5	162.1	3971.5
20.5	194.4	3985.2

The average pressure between the six measurements is 4034.1 mL*kPa. All measured product of pressure and volume were within 100 mL*kPa from the average. The first measurement has the largest difference, with a percent difference of 2.2%, so we can conclude that Boyle's law is accurate.