Lab 1: Verification of Boyle's Law

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Introduction

In the seventeenth century, Robert Boyle and his colleague Robert Hooke discovered the first gas law, now called Boyle's Law. Boyle made the discovery using a U-shaped glass tube with mercury inside to vary the pressure on a fixed weight of air. Doing so, he then discovered that pressure multiplied by volume is a constant, meaning when the pressure increases, the volume decreases in a relative manner. Although this law is true, it is only in effect with an ideal gas and when temperature is constant so slight errors should be expected. In this experiment, we should be able to prove this law by calculating the pressure(kPa) in a syringe at certain volumes(mL) and verifying that the relationship between these values is in accordance with Boyle's law (P1V1 = P2V2). Another relationship we should be able to verify in the inverse relationship between pressure and volume.

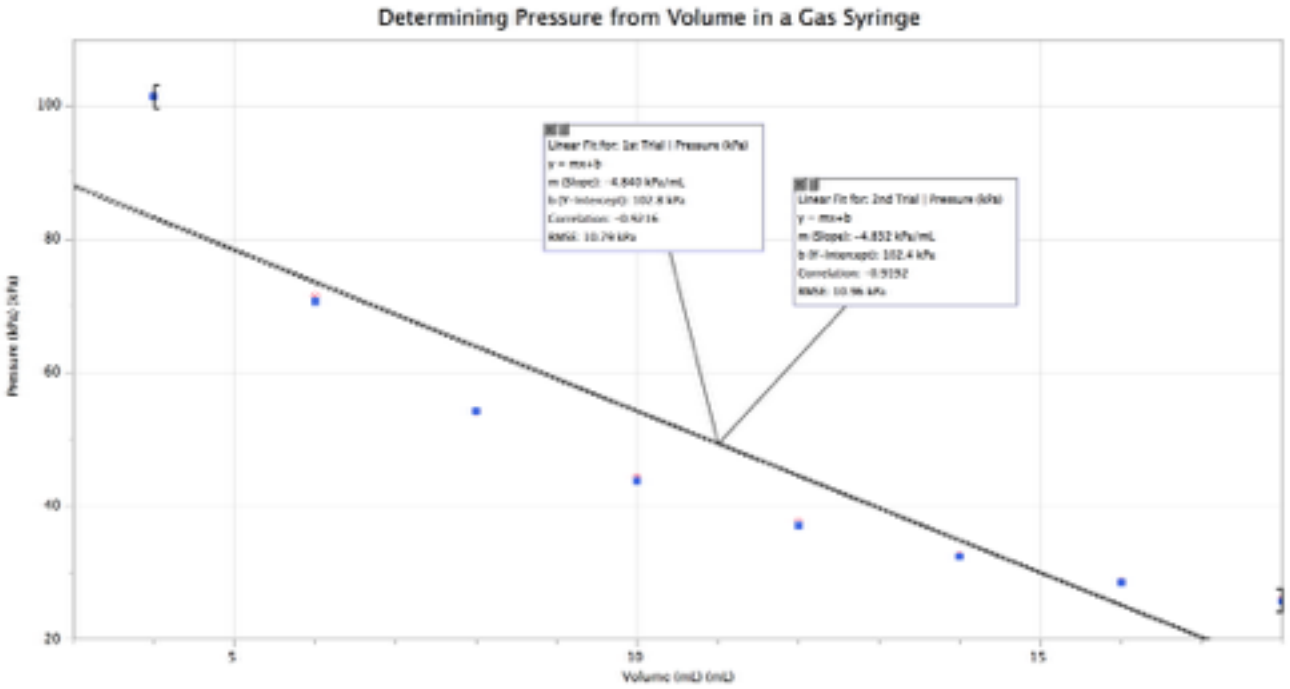
Procedure

As described in the manual ("DO I DARE DISTURBE THE UNIVERSE?", T.S. Eliot, Exp. 1, p.4-5).

Data & Observations/Results

Volume (mL)	1st Trial: Pressure (kPa)	2nd Trial: Pressure (kPa)
4.8	101.40	101.4
6.8	71.53	70.75
8.8	54.33	54.20
10.8	44.4	43.76
12.8	37.6	37.12
14.8	32.64	32.4
16.8	28.77	28.58
18.8	26.04	25.85
4.8 (2nd time)	101.57	104.45

Graph



Calculations

According to Boyle's Law:

P1V1 = P2V2

From our data (Volume, and Trial 1 pressure values used at volumes 4.8mL and 6.8mL):

P1V1 = P2V2

(Pressure (P1))101.4kPa x (Volume (V1)) 4.8mL = 486.72

(Pressure (P2))71.53kPa x (Volume (V2))6.8mL = 486.40

486.72 = 486.40

Since the multiplication results of both pressures and their respected volumes are very closely related, we can say that Boyle's law is verified to be the same as our experimental results.

Discussion

The experiment proved Boyle's Law by showing the correct relationship between pressure and volume. Our calculations show that our values from the experiment can be used to successfully verify Boyle's Law. Moreover, through this experiment we observed the inverse relationship between pressure and volume. As the volume in the syringe increased, the pressure decreased and vice versa; this observation is in accordance with Boyle's law.

Minor sources of error that occurred during the experiment are also taken into consideration. For example, Boyle's Law only occurs when temperature is constant and an ideal gas is used. In real life, there is no such thing as an ideal gas so this was neglected in the experiment. The temperature cannot stay perfectly constant due to heat produced by our hands. When pulling back the syringe, our hands produce heat which can affect the temperature, and therefore also affecting the pressure value.

Another error occurred during our first trial when we measured the pressure at the initial volume of 4mL for the second time. The pressure at 4mL was asked to be measured by pushing air into the syringe, decreasing the volume in the syringe, and therefore adding pressure. The error in our trial is due to the fact that the syringe was completely removed from the sensor, and therefore pressure was lost when the measurement was taken and resulted in an error.

Lastly, another possible source of error is atmospheric pressure. Atmospheric pressure is the force exerted on a surface by the air that surrounds us due to gravity. This pressure changes with a few factors such as altitude, the temperature, and the time of day, as it is constantly changing. This source of error should be taken into consideration as the atmospheric pressure may have changed, which would impact the pressure acting on the syringe and therefore changing our results.

Conclusion

In conclusion, Boyle's law was verified since our inputted results of pressure and volume into Boyle's Law equation gave the outcomes we expected. According to Boyle's Law, the product of the pressure and volume at a certain volume should match the product of the pressure and volume at another volume ($P_1V_1 = P_2V_2$)—while temperature is constant. Our experiment stayed true to this law. Finally, our experiment showed the inverse relationship between pressure and volume at a constant temperature; as the volume in the syringe increased, the pressure decreased and vice versa.

References

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