Experiment 1
VERIFICATION OF BOYLE'S LAW

Introduction:

In 1662, the British Chemist- Robert Boyle presented the Boyle's Law according to his experimental results. He found the relationship between the pressure and volume of a gas when the mass of the air and temperature was kept constant. He theorised that this was because small air particles existed freely in the air and as the volume decreased, there were more air particles per unit volume which meant more force per area. This resulted in higher pressure. Similarly, the same applied to when the volume increased which meant the pressure decreased- since there were less air particles per unit volume and so force was lower per area. This meant that "the pressure of gas is inversely proportional to its volume. [1]

In this experiment, we verified Boyle's Law. We used a 20mL gas syringe and a Vernier gas pressure sensor. In order to keep the experiment accurate, we kept the temperature and mass of air constant. The Boyle's Law can be expressed as

$$\mathbf{P1V1 = P2V2}$$

P is pressure of gas, V is volume of gas.

Reference:

[1]Occupational Medicine, A practical demonstration of Boyle's Law(Mike Gibson, 2015, p.109)

Procedure: As described in the lab manual. (Do I Disturb The Universe? By T.S Eliot p. 4-5) Just make sure to have hair tied back, googles on, desk and surrounding area on the ground are clear to prevent safety hazard.

To keep errors to a minimum, stay in one place and area while doing the experiment to keep temperature as constant as possible.

Observations:

As we pulled the syringe and the volume increased, the pressure decreased. Due to this, as we increased the volume, it got harder to pull the syringe especially at the final reading of 16.8ml as it was tough to keep it stable to get an accurate reading.

Data table:

Independent variable (Volume, mL)	Dependent variable Trail 1 (Pressure, kPa)	Dependent variable Trail 2 (Pressure, kPa)
2.80(The first time)	19.61	19.53
4.80	10.32	10.59
6.80	7.310	7.560
8.80	5.620	5.690
10.8	4.810	4.830
12.8	4.100	4.230
14.8	3.750	4.090
16.8	3.400	3.050
*2.80(The second time)	*20.07	*20.52

* The data will not use in the calculations part and graphs part.

Calculations :

Trail 1 :

a) P1*V1(The first time) =19.61 * 2.80 = 54.908
b) P2*V2 = 10.32 * 4.80 = 49.536
c) P3*V3 = 7.310 * 6.80 = 49.708
d) P4*V4 = 5.620 * 8.80 = 49.456
e) P5*V5 = 4.810 * 10.8 = 51.948
f) P6*V6 = 4.100 * 12.8 = 52.480
g) P7*V7 = 3.750 * 14.8 = 55.500
h) P8*V8 = 3.400 * 16.8 = 57.120
i) Average value 1= (54.908+49.536+49.708+49.456+51.948+52.480+55.500+57.120) / 8 = 52.582

Trail 2 :

a) P1*V1(The first time) = 19.53 * 2.80 = 54.684
b) P2*V2= 10.59 * 4.80 = 50.832
c) P3*V3= 7.560 * 6.80 = 51.408
d) P4*V4= 5.690 * 8.80 = 50.072
e) P5*V5= 4.830 * 10.8 = 52.164
f) P6*V6= 4.230 * 12.8 = 54.144
g) P7*V7= 4.090 * 14.8 = 60.532
h) P8*V8= 3.050 * 16.8 = 51.24
i) Average value 2= (54.684+50.832+51.408+50.072+52.164+54.144+60.532) / 8 = 46.7295

Average value of Trail 1 and 2:

Average value = (Average value 1 + Average value 2) / 2 = 49.65575

Graphs :

Figure 1 : The graph of the pressure versus volume of the gas which is kept in the syringe(Trail 1)

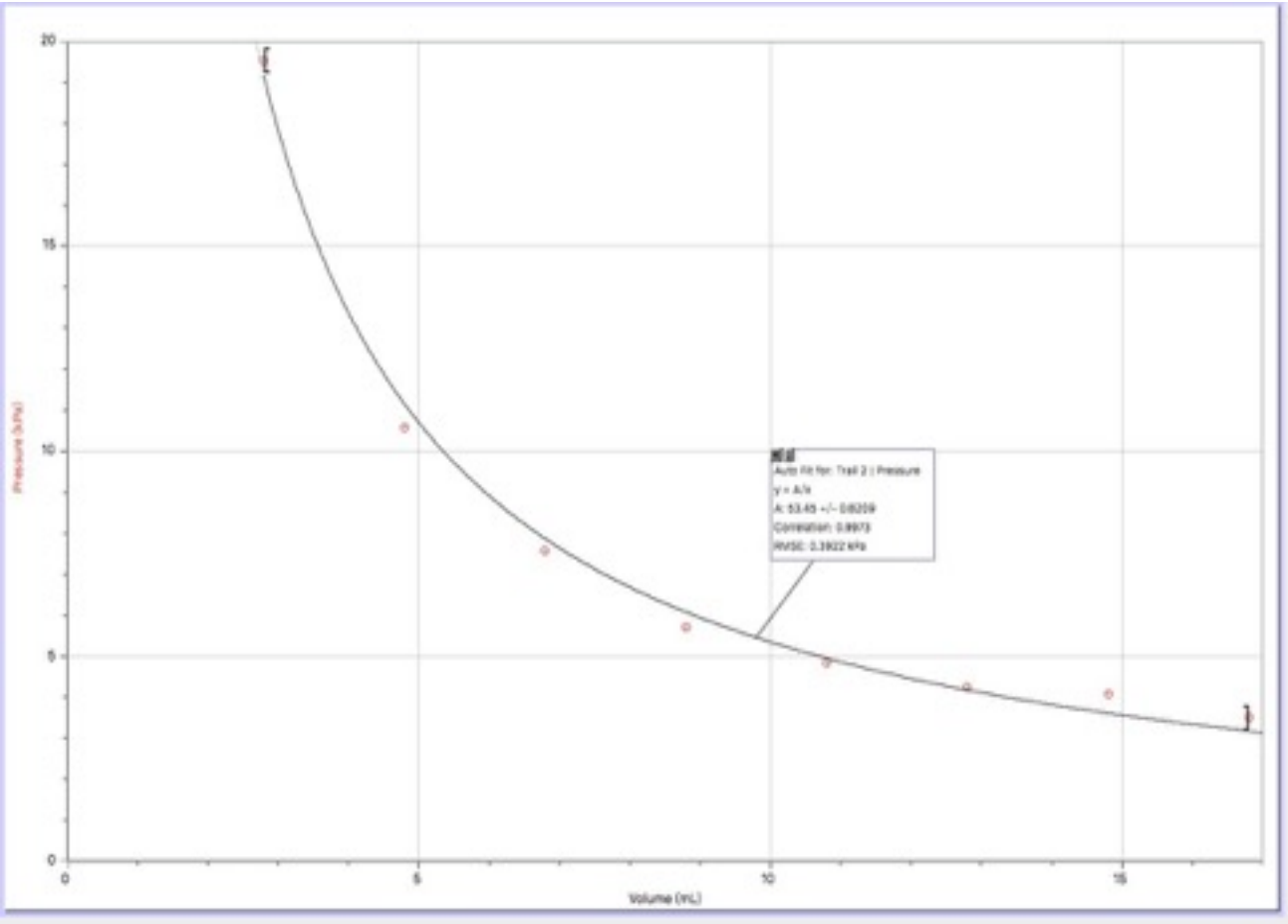

Figure 1: Y-axis represents pressure and X-axis represents volume. This graph shows the functional relation between pressure and volume which use the data of trail 1.

Figure 2 : The graph of the pressure versus volume of the gas which is kept in the syringe(Trail 2)

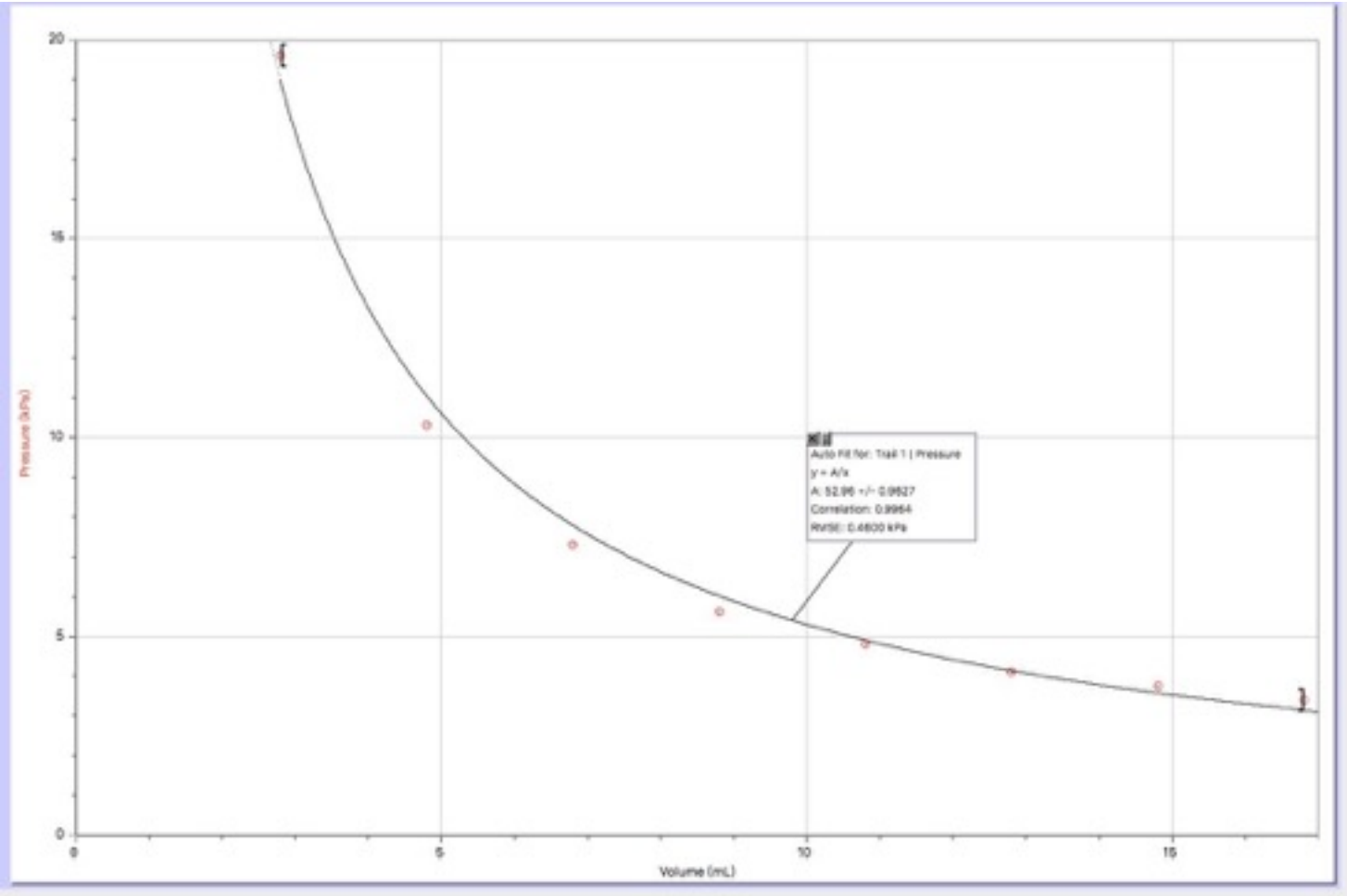

Figure 2: Y-axis represents pressure and X-axis represents volume. This graph shows the functional relation between pressure and volume which use the data of trail 2.

Figure 3 : The graph of the K / pressure versus volume of the gas.

K / pressure = Volume

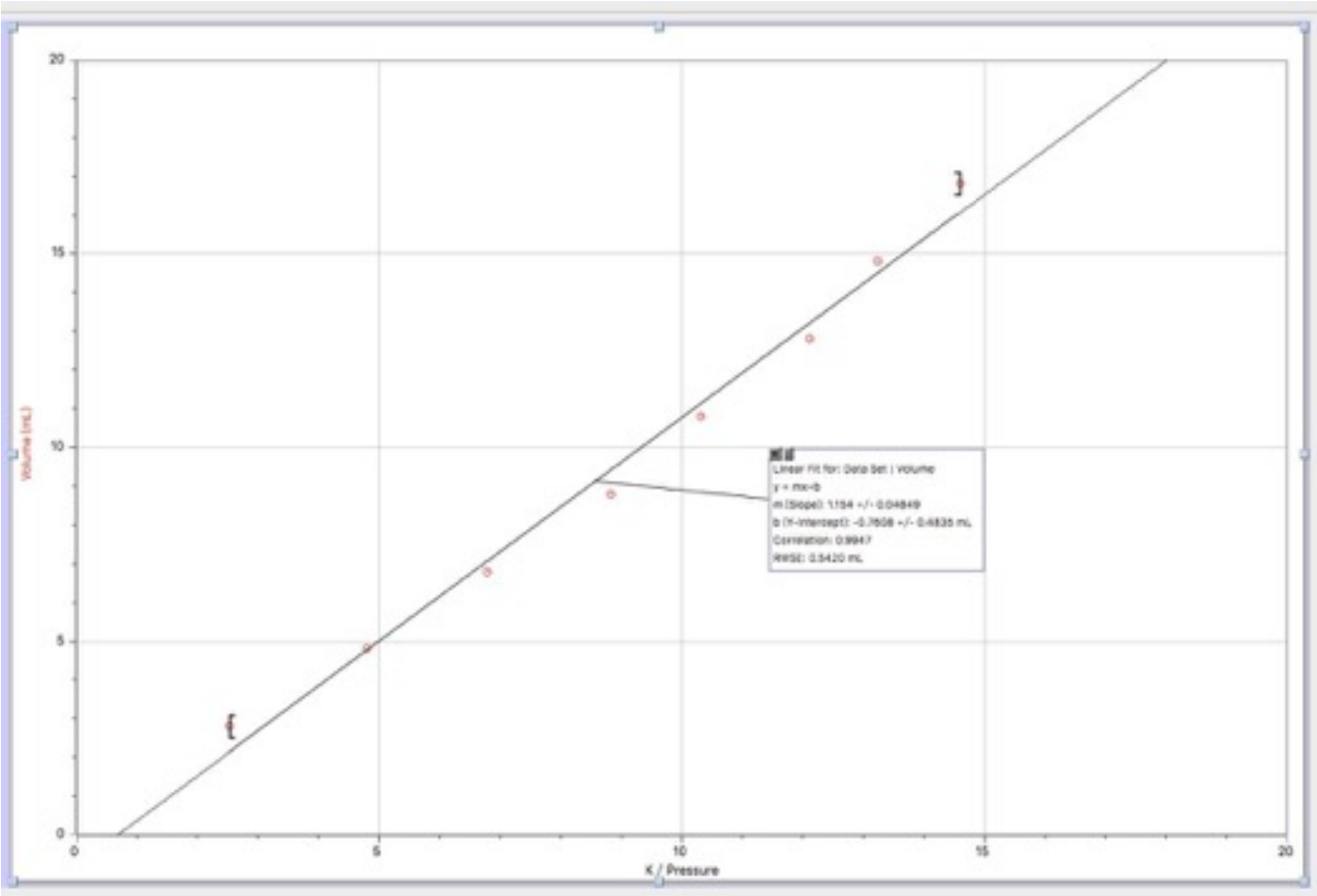

Figure 3: Y-axis represents K divided by pressure and X-axis represents volume. This graph clearly shows the relationship between pressure and volume of gas. K is constant which is the average value of trail 1 and 2.

Discussion:

Looking at the results, a relationship between the pressure and volume was obvious. As the volume increased, the pressure decreased. This inversely proportional relationship was evident in the graph as a inverse function.

This theory was evident in our results. We observed a comparatively high pressure of 19.61 kPa when we first started at a volume of 2.8ml. When we increased the volume to 4.8ml, we saw a drop in pressure to 10.32kPa. This supported Boyle's theory as the reason why this occurred was most likely due to the decrease of air particle per unit volume which meant the force per area decreased as well. As the volume of the container increased to 6.8ml, 10.8ml, 12.8ml, 14.8ml and 16.8ml, we saw a decrease in pressure 10.32kPa, 7.31kPa, 5.62 kPa, 4.81 kPa. 4.1 kPa, 3.75 kPa and 3.4 kPa. This proved the inverse relationship Boyle had discovered between volume and pressure- as volume increased, the pressure decreased, as long as the mass of air and temperature was kept constant.

When we applied Boyle's Law to the results, we found that it wasn't exact. For example, when we inputted out first and second results into P1V1=P2V2 (2.8*19.61) =(4.8*10.32) we got 54.908=49.536. These results were similar to our 3rd and 4th results of (6.8*5.62)49.708=(8.8*5.62)49.456. This might've been due to human and experimental error. An example of human error could've been measuring the volume of the container as keeping it stable at specific points like 2ml,4ml,6ml etc proved to be difficult. This small instability might've caused a slight difference in volume and, thus, the pressure. Another example would've been temperature. We couldn't completely control the temperature of the room or the temperature of our hands holding the syringe. Also, there's a possibility the syringe or the Vernier Gas Pressure Sensor might've had a small opening where air particles can come through. This would've changed the total mass of air which subsequently might've change the pressure.

Conclusion:

To sum it up, this experiment proved Boyle's Theory that there's an inverse relationship between volume and pressure. The numbers might not have been exact but overall, the decrease of pressure was inversely proportional to the increase in volume according to our data and graphs.

In order to improve the experiment next time, we should use a smart device enclosed in a box to keep the temperature completely constant throughout the experiment and to lessen human error. This way we can obtain more accurate results.