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# Lab 3 – Ideal Gasses

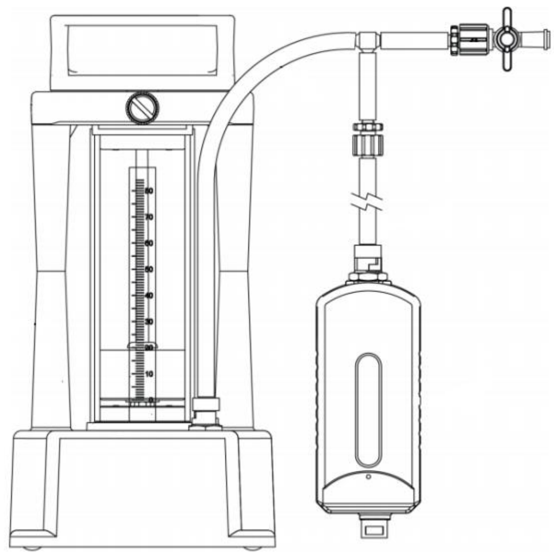
## Part 1: Boyle's Law

*What is the relationship between Pressure and Volume of an ideal gas?* It is important that while attempting to answer such a question, all other variables remain unchanged.

Equipment Needed

Heat Engine, Pressure Sensor, Tubing, Valve

Experimental Design



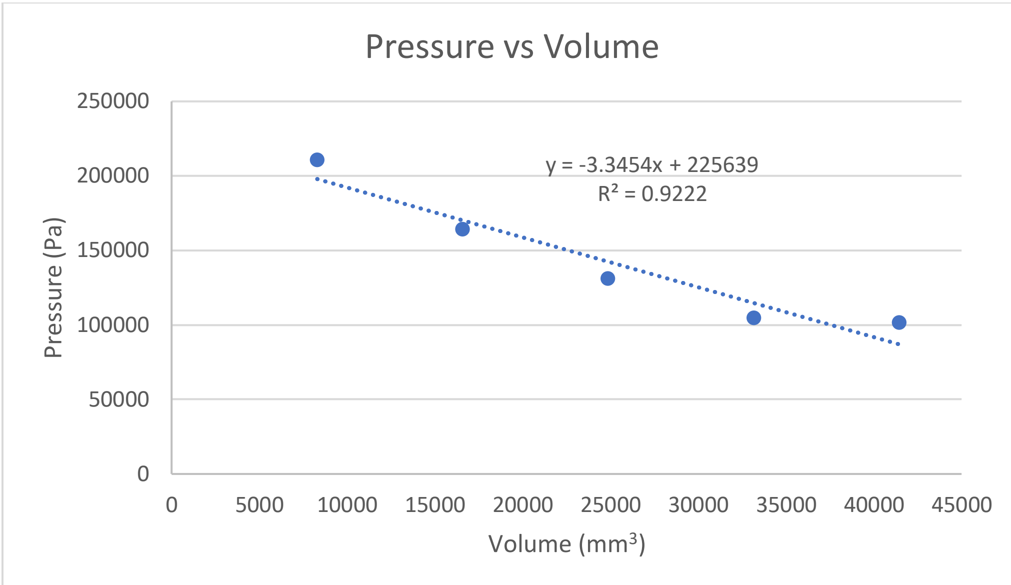
1. Orient your lab equipment in the method shown.

2. Turn the valve's handle to a position parallel to the tubing to allow air flow (UNLOCKED position). While unlocked, raise the heat engine's piston position to some value of your choosing. Be sure to make room for compressing and expanding the air inside the piston. Once you have established this position, LOCK the valve by orienting the handle to be perpendicular to the tubing.

3. Begin recording various volumes and associated pressures by either manually moving the piston or adding controlled weights. Keep in mind that the side of the piston reads length in MILLIMETERS and not volume. The piston is a cylinder with an inner diameter of 32.5 mm.

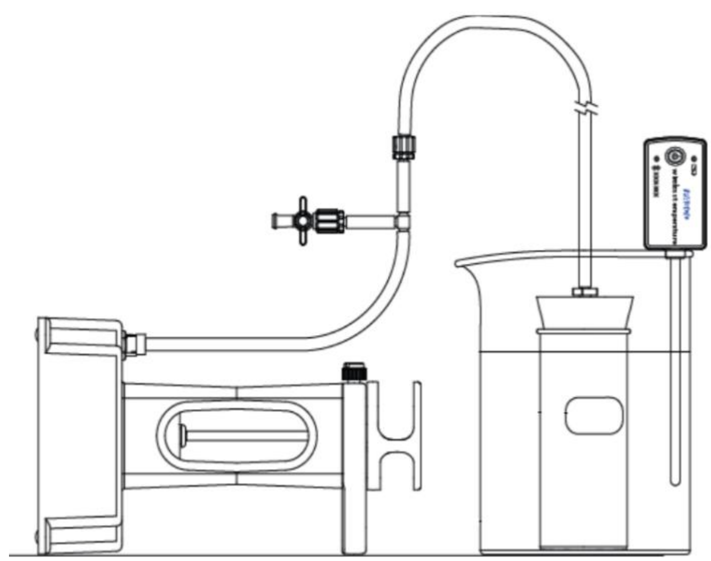
4. Below, please paste your data. This should include a data table and a Pressure vs. Volume graph. Please fit both side-by-side on the 1st page. Do not worry about linearizing your data.

| Volume ($mm^3$) | Pressure (Pa) |
|---|---|
| 41478.84 | 101609 |
| 33183.07 | 104603 |
| 24887.3 | 131077 |
| 16591.54 | 163885 |
| 8295.77 | 210731 |


Pressure vs Volume
y = -3.3454x + 225639
R² = 0.9222
Pressure (Pa)
250000
200000
150000
100000
50000
0
0
5000
10000
15000
20000
25000
30000
35000
40000
45000
Volume (mm3)

## Part 2: Charles' Law

*What is the relationship between Volume and Temperature of an ideal gas?* It is important that while attempting to answer such a question, that all other variables remain unchanged.



Equipment Needed

Heat Engine, Beaker, Temperature Sensor, Hot Plate, Tubing, Aluminum Air Canister, Microwave, Valve

Experimental Design

1. Orient your lab equipment in the method shown. Do not submerge the canister in the beaker yet, though.

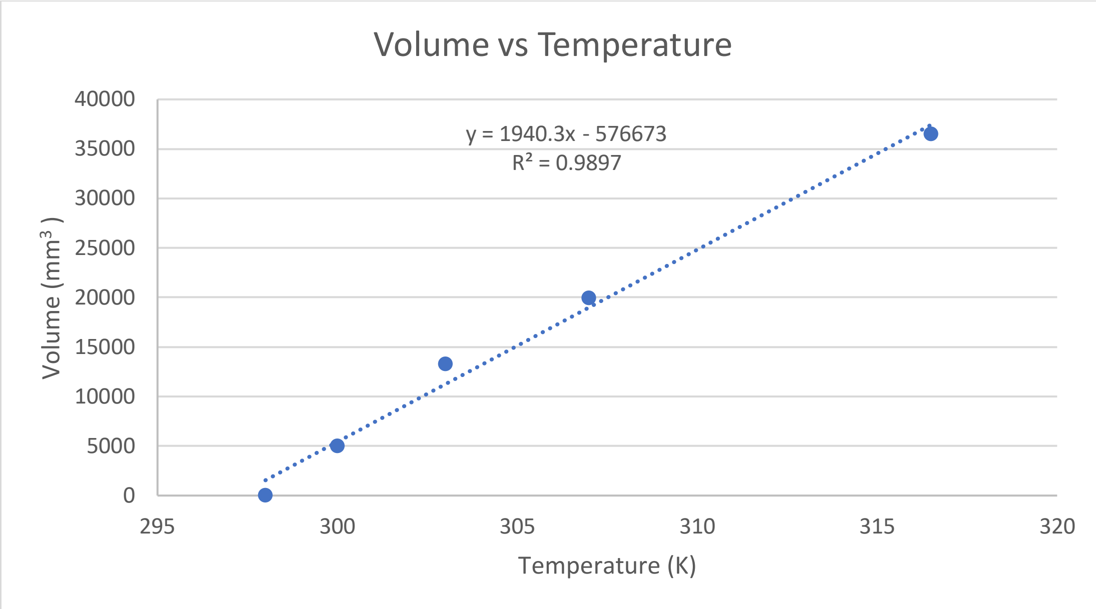
2. UNLOCK the valve and assure the black rubber stopper is firmly fit into the canister. Adjust the piston to the zero position. LOCK the valve after this.

3. Fill the beaker about half way with room temperature water. Use the microwave to heat the water to *almost* boiling. If the water is too hot, the stopper will pop off and the experiment will have to be repeated. Place the aluminum canister inside the beaker so the entire canister is submerged. One person will have to hold this steady by the STOPPER. Do not touch the aluminum. Another person will need to hold the temperature sensor steady as well, and not let it touch the bottom of the beaker.

4. When the air stops expanding, record the maximum volume and temperature (Kelvin). Slowly reduce the temperature by adding ice in slow intervals. Record volumes and temperatures at intervals of your choosing

5. Below, please paste your data. This should include a data table and a Volume vs. Temperature graph. Please fit both side-by-side on the 2nd page.

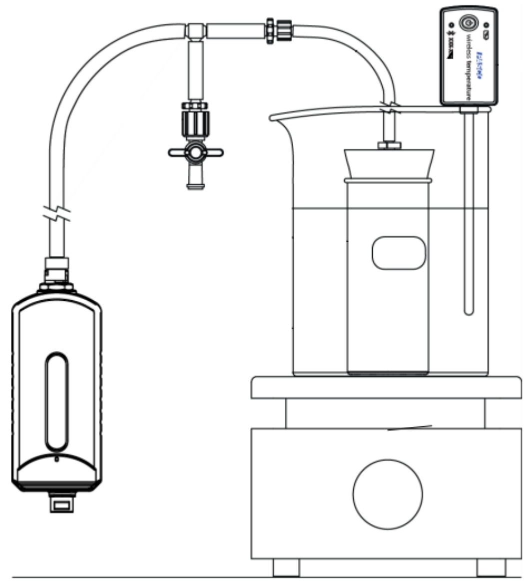
| Temperature (K) | Volume ($mm^3$) |
|---|---|
| 316.5 | 36501.38 |
| 307 | 19909.84 |
| 303 | 13273.23 |
| 300 | 4977.46 |
| 298 | 0 |



Volume vs Temperature
y = 1940.3x - 576673
R² = 0.9897
40000
35000
30000
25000
20000
15000
10000
5000
0
295
300
305
310
315
320
Temperature (K)
Volume (mm3 )

## Part 3: Gay-Lussac's Law (Goggles and Apron Required)

*What is the relationship between Pressure and Temperature of an ideal gas?* It is important that while attempting to answer such a question, that all other variables remain unchanged.



Equipment Needed

Beaker, Temperature Sensor, Pressure Sensor, Hot Plate, Tubing, Aluminum Air Canister, Valve

Experimental Design

1. Orient your lab equipment in the method shown. Do not submerge the canister in the beaker yet, though.

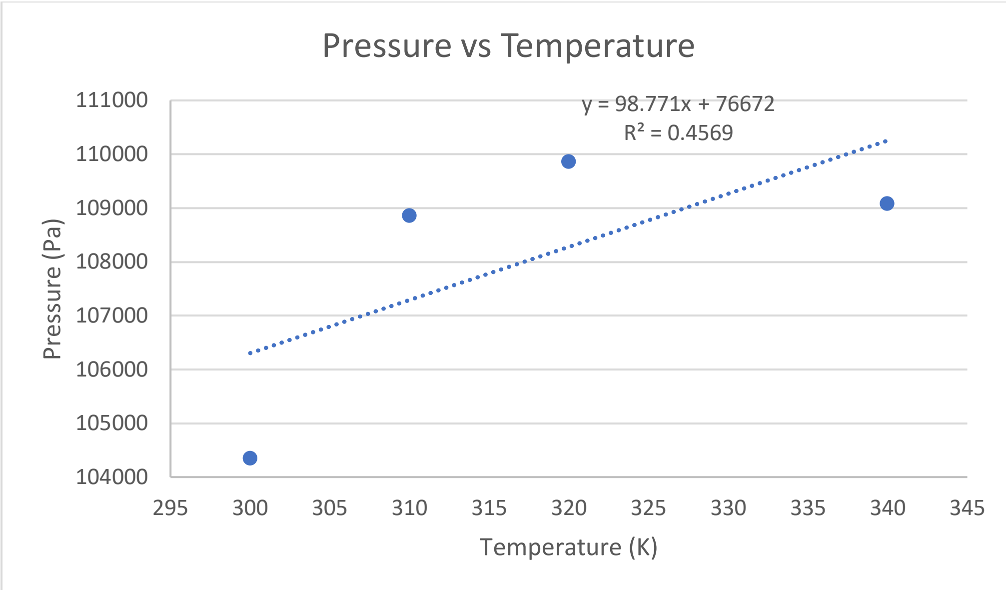
2. UNLOCK the valve and assure the black rubber stopper is firmly fit into the canister. LOCK the valve after you have done so.

3. Fill the beaker about half way with room temperature water. Place aluminum canister inside, but do not let it touch the bottom. One person will have to hold this steady by the STOPPER. Do not touch the aluminum. One other person will need to hold the temperature sensor steady, and not let it touch the bottom of the beaker.

4. Place the beaker on a hot plate and turn it on. Begin recording pressures and temperatures (Kelvin) at intervals of your choosing. When the temperature reaches 80° C, or when the stopper pops off, stop recording and unplug the hot plate.

5. Below, please paste your data. This should include a data table and a Pressure vs. Temperature graph. Please fit both side-by-side on the 3rd page.

| Temperature (K) | Pressure (Pa) |
|---|---|
| 300 | 104344 |
| 310 | 108853 |
| 320 | 109853 |
| 340 | 109076 |


Pressure vs Temperature
y = 98.771x + 76672
R² = 0.4569
111000
110000
109000
108000
107000
106000
105000
104000
Pressure (Pa)
295
300
305
310
315
320
325
330
335
340
345
Temperature (K)

## Questions

1. What is the relationship between Pressure and Volume? Include your regression equation from Part 1.

   According to the data we collected in part one, pressure and volume seem to be inversely proportional as shown by the negative linear graph produced. As volume increases, pressure decreases, resulting in the equation $y = -3.3454x + 225639$. This relation seems to be fairly accurate as we ended with a $R^2$ value of 0.92224.

2. What is the relationship between Volume and Temperature? Include your regression equation from Part 2.

   Volume and temperature appear to have a directly proportional relationship as seen by the positive linear graph in our data. As temperature increases, volume increases as well, leading to the calculated equation $y = 1940.3x – 576673$. This relationship seems to be accurate as we calculated an $R^2$ value of 0.9897.

3. What is the relationship between Pressure and Temperature? Include your regression equation from Part 3.

   The relationship between pressure and temperature appear to be directly proportional as evident by the near linear graph in our data. Pressure steadily increases as the temperature is raised as shown by the resulting equation of $y = 98.771x + 76672$. Although we have a relatively low $R^2$ value of 0.45694, we are still fairly certain of this relation as our data was somewhat inaccurate due to various factors during the experiment.

4. What are some sources of error that might have occurred during your laboratory experiment?

   In part one, a possible source of error was significant amounts of pressure being released before we could record the accurate reading, leading to a slight difference between our collected data and the actual pressure at that given volume. For part two, a possible source of error is the limit of the heat engine. Since the most accurate measurement for depth was only to a millimeter, when we calculated the volume we only knew the specific measurement up to there. If we were to perform this experiment again, preferably we’d be able to access more accurate measurement tools. Finally, in part three, a major source of error was that the cap of the aluminum tube popped off in the middle of the experiment resulting in the loss of a significant amount of pressure leading to our faulty data. We definitely require a few more retrials in order to collect more accurate results for part three.