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PHYSICS COURSE WORK
TASK 2

P2 PASS PART

The aim – the aim is to justify as well as verify Boyle's law in the experiment been carried out which is the sample of air with in an oil reservoir.

BOYLE'S LAW STATES:

The volume of a gas varies *inversely* with the pressure, while the density of a gas varies *directly* with pressure at constant temperature.
Simplified: As air pressure increases the volume of a gas decreases, and vice versa with temperature been kept constant. Where P is pressure and V is volume, and K is a constant. The change of P and V will change in the opposite direction, so that their product is kept in check at a constant value.

$$P \propto \frac{1}{V} \quad \text{(at constant temperature)}$$

$$\text{i.e., } PV = \text{Constant}$$

Apparatus

- The bourdon gauge
- The foot pump
- The Boyle's law pressure apparatus
- The glass tube
- Oil reservoir

A sample of dry air is confined in a tall, wide glass tube by a piston of oil. The volume is found from the length of the air column, which should be clearly visible at the back of the class. The pressure is read from a Bourdon gauge connected to the air over the oil reservoir. This is calibrated to read absolute pressure and is visible from the back of the class.

The foot pump is attached to the oil reservoir and is used to change the pressure. The gauge reads up to 3×10^{5} N m^{-2} and the pressure can safely be taken up to this value but must not be taken beyond. To fill the apparatus with oil, unscrew the Bourdon gauge with a spanner and fill the chamber with low vapour pressure oil. Tilt the apparatus in the final stage of filling in order to get enough oil into the main tube. When re-fixing the gauge, tighten the nut to get a good seal, but not so much that the thread is damaged.

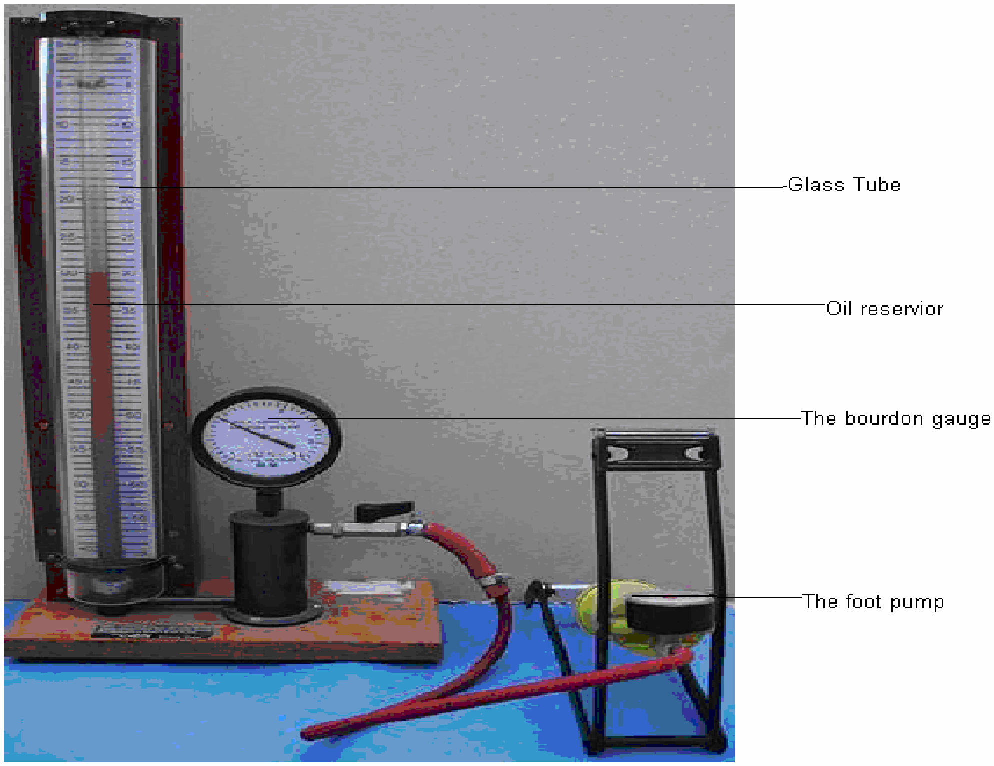

Photo courtesy of J Kin chin

Procedure

- Give a quick demonstration to show that doubling the pressure halves the length of the air column, and so its volume.
- Increase the pressure to its maximum value, and then record it and the (minimum) length of the air column.
- Next, disconnect the pump and release a little air using the valve on the oil reservoir, so that the o il level in the tube falls a few centimeters.
- Before taking the next pair of readings, wait a while so that the air temperature recovers and the oil left behind has falle n down the wall of the tube.
- Keep repeating step until the gauge returns to atmosp heric pressure.

Results

Firstly, the initial pressure is 3.4×10^5 N/m^2
Initial volume 6.9 cm^3

Pressure N/m^2	Volume cm^3
2.7×10^5	9.0
2.3×10^5	11.0
1.82×10^5	14.0
1.62×10^5	16.0
1.43×10^5	18.0
1.3×10^5	20.0
1.18×10^5	22.0
1.1×10^5	24.0

Experimental Procedure - Data

My secondary data from an industry, the apparatus used where computer, Vernier computer interface, Logger Pro, Vernier Gas Pressure Sensor, 20 -mL gas syringe.

Volum e (mL)	Pressure(kPa)
20	52.7
18	56.6
16	64.5
14	73.7
12	85.5
10	101.1
8	126
7	142.6
6.5	153.3
6	163.6
5.5	174.3
5	189.9

My comparism from the above data is that the pressure increases as the volume decreases which gives us the similarity of but data. We can also notice that their above results the volume is used and calculated in milli l itre while ours was used and calculated in centimetres.
In addition to that, the industry used a different apparatus while we carrying out our own experiment in the lab used a different apparatus that was available for us to use but at the same time we ar e all investigating on the same thing.

Variables

The variables are pressure and volume while temperature is kept or remain constant.

Analysis

Verifying Boyle's Law
Since
p V = constant
p = constant / **V**

Thus, fitting **p** versus 1/**V** to a straight line should give a good fit with an intercept equal to zero within errors.
However, a systematic error in the volume is possible because the top of the column of air in the tube is not well defined. This can give a poor fit to the above relation.

From the results above and from my graph you can see that as the pressure decreases while the volume increases at a constant temperature just like my theory stated. As the volume increases, the numbers of gas molecules are constant. Hence, the pressure in the molecules decreases, as there is less collision of molecules. This means that the more we carry out the same procedure, which is the number of times we repeated our experiment, gives us a better and accurate results.

From the table it can be seen that for the volume $9.0cm^3$ increases and pressure decreases because the oil in the reservoir reduces and this increases the air space area in the gauge. As the method was repeated continuously the volume increased with every $2cm^3$ while the pressure reduced randomly between four – one N/m^2. During my experiment, I noticed that one has to be careful in releasing the air from the pressure instruments because if not the difference in volume will not be at equal level and this in turn affects the pressure, which also decreases randomly, and this is not require because we are trying to determine the consistency of the gas molecules.

Finally, I will say that my graph as well as my results obeys Boyle's law as the pressure is inversely proportional to the volume that is the decr ease in pressure leads to the increase in volume.

Safety / risk assessment

The glass tube is known to fly upwards when the gas is at maximum pressure. To prevent this, I checked the compression joint holding the tube and any tube supports before using it. I also made sure that when pulling the air into the oil reservoir enough care was taken because if not the oil reservoir could be over filled with maximum volume of oil in the oil reservoir causing the glass to break which can hurt anyone around.
The apparatus used was actually a heavy one, which needed to be kept at a particular position and smooth surface this is so because it will be a risk if not kept and handled properly. Hence, I made sure that the apparatus was kept in a smooth surface and the instruments provide for us to use was used following specific instructions, which is also part of the risk assessment, why? Because the students has to be able to use the apparatus given to them, because if they are not able to use it they are putting themsel ves at risk.

Conclusions:

This experiment has been a method, which has been practiced from over 200 years ago, and this does not contain any of the typical units used in modern scientific experiments, the relationship between pressure and volume from Boyle's original data set could still be determined, as the pressure is inversely proportional to the volume at a constant temperature. This has been shown by analyzing Boyle's data using graphical analysis, it was possible to verify the accuracy of this "bourdon gauge" which shows us the relationship: P1V1 = P2V2.

M2 merit part

$P_1 = 2.00 \times 10^5$
$V_1 = 100cm^3$
$T_1 = 29^oc + 273 = 302^ok$

$P_2 = 5.00 \times 10^5$
$V_2 = ?$
$T_2 = 77^oc + 273 = 350^ok$

i) $\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$

$$\frac{2.00 \times 10^5 \times 100}{302} = \frac{5.00 \times 10^5 \times V_2}{350}$$

$5.00 \times 10^5 \times 302 \times V_2 = 2.00 \times 10^5 \times 100 \times 350$
$151000000 \times V_2 = 7000000000$

$$V_2 = \frac{7000000000}{151000000}$$

$= 46.35761589$
$\approx 46.36cm^3$

ii) $P_1 = 101$
$V_1 = ?$
$T_1 = 273$

$P_2 = 2.5 \times 10^3$
$V_2 = 4l$
$T_2 = 15^oc = + 273 = 288$

$$\frac{101 \times V}{273} = \frac{2.5 \times 10^6 \times 4}{288}$$

$V = 93.85litres$
$= 9.39 \times 10^4 cm^3$

b) $\rho = m/v$

$= 1.4 \times 10^{-3} \times 9.39 \times 10^{-4}$

$= 131.39g$ to kg $\div 1000$
$= 0.13kg$

D2 distinction part

In addition, Boyle's law also relates to gas *density* so when the pressure of a fixed volume of gas increases the density increases as well and this is vice versa which means that the pressure and volume of a gas are *inversely* proportional while the pressure and density of a gas are *directly* proportional. Firstly, the gas particles are in constant motion but when pressure is realized, the gas particles begin to collide with each other. The gas particles also collide with the walls of a container. This gas exerted, exerts a push on the walls of a container. Pressure is measured in kilopascals (kPa).

Math Application: Pressure = Force ÷ Area

Hence,

- When the pressure of a gas increases, then its volume decreases. ↑P ~ ↓V
- When the pressure of a gas decreases, then its volume increases. ↓P ~ ↑V

The syringe connected to a gas pressure sensor is used to study the relationship between pressure and volume. The syringe allows for the change in the volume of the gas. The pressure sensor will monitor the changes in gas pressure as the volume changes. Then the graph of pressure and volume data is plotted.

Experimental Procedure

There are three main procedures to this experiment:

1. Set-up the computer.
2. Measure pressure in the syringe at various volumes.
3. Build the graphs.

PROCEDURE

1. Prepare the Gas Pressure Sensor and an air sample for data collection.
    a. Plug the Gas Pressure Sensor into Channel 1 of the computer interface.
    b. With the 20 mL syringe disconnected from the Gas Pressure Sensor, move the piston of the syringe until the front edge of the inside black ring (indicated by the arrow in Figure 2) is positioned at the 10.0 mL mark.
    c. Attach the 20 mL syringe to the valve of the Gas Pressure Sensor.
2. Prepare the computer for data collection by opening the file "06 Boyle's Law" from the **Chemistry with Vernier** folder of Logger **Pro**.
3. It is best for one person to take care of the gas syringe and for another to operate the computer. Click collect to begin data collection.
    a. Move the piston to position the front edge of the inside black ring at the 4.0-mL line on the syringe. Hold the piston firmly in this position until the pressure value stabilizes.
    b. When the pressure reading has stabilized, click keep. Type the gas volume in the window that appears. Press ENTER to keep this data pair. (After clicking keep but before entering a value).
    c. Move the piston to the 6.0-mL line. When the pressure reading has stabilized, click keep and type in the volume.
    d. Continue this procedure for syringe volumes of 8.0, 10.0, 12.0, 14.0, 16.0, 18.0 and 20.0 mL.
    e. Click stop when you have finished collecting data.
4. Proceed to the next steps, keeping your data on the computer screen.

Safety for the procedure

- There are no extreme hazards in this experiment; how ever, appropriate eye protection still needs to be worn.
- Do not "force" the connections. If you are having trouble making connections, please consult your laboratory instructor.
- When returning equipment to the stockroom, DO NOT WRAP CORDS TIGHT! This will damage the tiny wires and could cause a possible short circuit.

Waste Disposal

- There are no chemical wastes generated in this experiment.
- Be sure to return computers and Pasco equipment t o the stockroom.

Reference-

http://www.lakesidepress.com/pulmonary/books/scuba/sectiond.htm
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