The Ideal Gas Law

Introduction

The ideal Gas law is based on the simplification that interactions between, and the volume of each gas atom or molecule are negligible. This approximation is permitted for low gas concentrations within a closed system. The so-called Ideal Gas equation (developed by Boyle-Marriott and Gay-Lussac) quantifies the relationship between volume, pressure and temperature.

$$pV = nRT$$

p = pressure (T constant)

T = temperature (p constant)

V = volume

n = number of moles of gas

In this experiment, we investigate the connection between pressure and volume of air sealed in a flask.

Equipment

- A 5 ml glass flask.
- A rubber stopper
- A20 ml syringe
- Three 23 gauge syringe needles
- A short latex tube
- A long latex tube
- A pressure sensor (0 – 700 kPa)
- A MultiLog

Equipment Setup Procedure

1. Connect the MultiLog to the serial port of the computer and to the power supply.
2. Turn the MultiLog on.
3. Connect the pressure sensor to the I/O port of the MultiLog.
4. Assemble the equipment so that the syringe is connected to the flask by a three-way valve while the pressure sensor is connected directly to the flask (compare Fig. – 1).
5. Set the MultiLog up according to the setup specified below. You can set up the MultiLog either by using the MultiLog keypad or using the Setup Wizard in MultiLab (click **Setup Wizard** 

on the main toolbar).

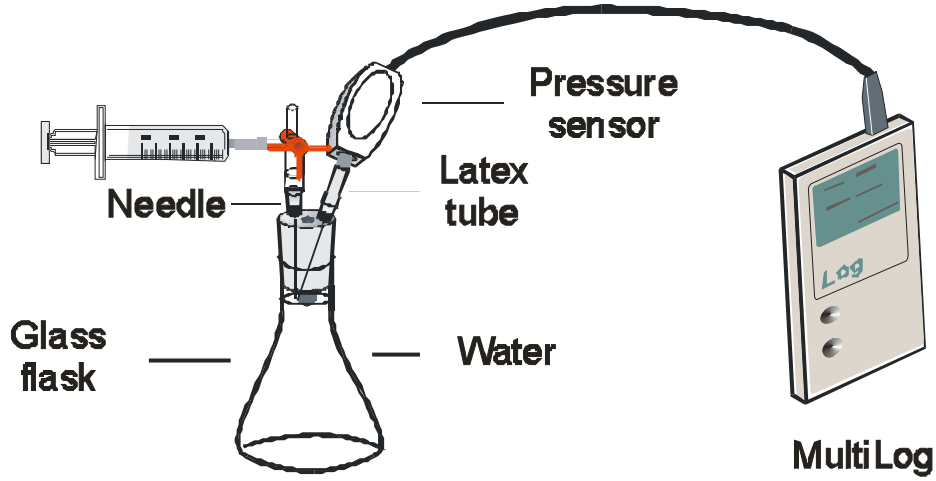


Figure 1

MultiLog Set Up

- Input 1: Pressure (0 – 700 kPa)
- Rate: Manual
- Samples: 50

Experimental Procedure

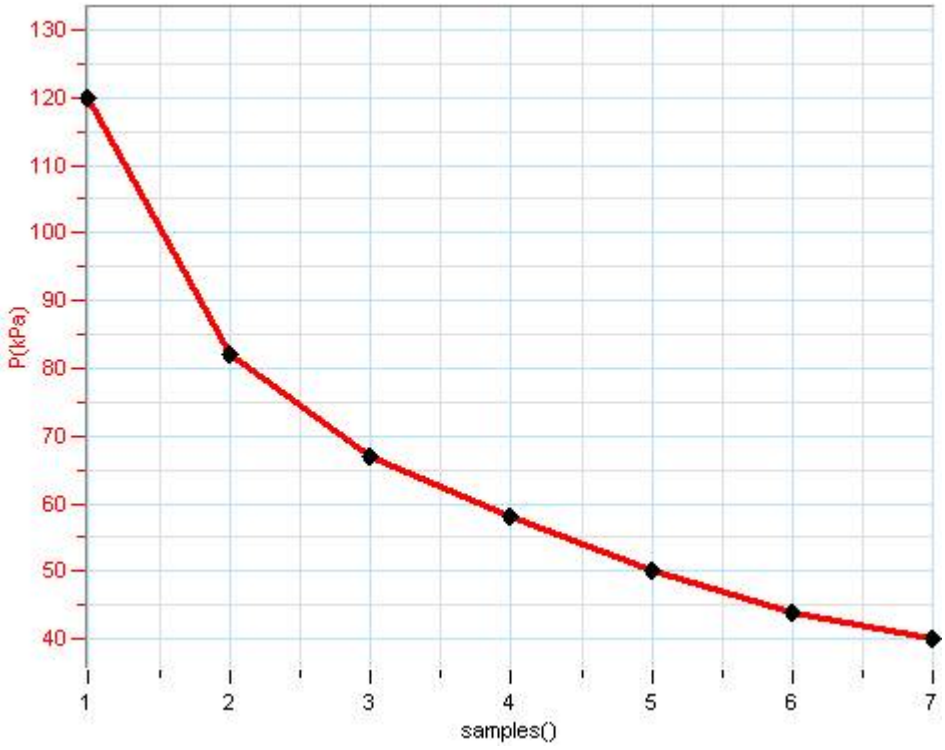
1. Close the flask tightly with the rubber stopper and insert the needles connecting the syringe and the pressure sensor with the gas space inside the flask respectively.

2. Turn the three-way valve so that the system is closed.
3. Start the MultiLog either from the MultiLog Panel or from **MultiLab**: click **Run** on the main toolbar.
4. Pull the syringe stamp in about six 2 ml increments. Collect the data manually:

   Push the **Enter** button on the MultiLogPRO (or the **Samples,** button on the MultiLog) any time you wish to collect data. Write the volume increments down, as you will add them later to your data!

Data Analysis

The above-described experiment results in the following plot of pressure decrease versus number of collected samples:



In order to plot a function presenting the relation between pressure and volume, you have to add the values for the volume increments to the worksheet:

1. Enter the volume data to a manual column:
   i) Click **Table** on the menu bar, then click **Capture**

ii) Click **Insert manual column**

iii) In the **Column title** edit box enter a name (e.g. V)

iv) In the **Unit** edit box enter a unit (e.g. mL)

v) Click **OK**

vi) Click **OK**

vii) In the table, click the first cell of the new column and enter the volume of the first sample. Use the arrow keas on the keyboard to move to other cells and fill the column

2. Create a graph of 1/V:

i) Click **Edit graph** on the graph toolbar

ii) Select Capture 1: V in the **Y-axis** list, then click **OK**

iii) Use the cursor to select the volume graph

iv) Click **Analysis Wizard** on the main toolbar, then click the **Functions** tab

v) In the **Functions** drop list select **Reciprocal (1/x)**

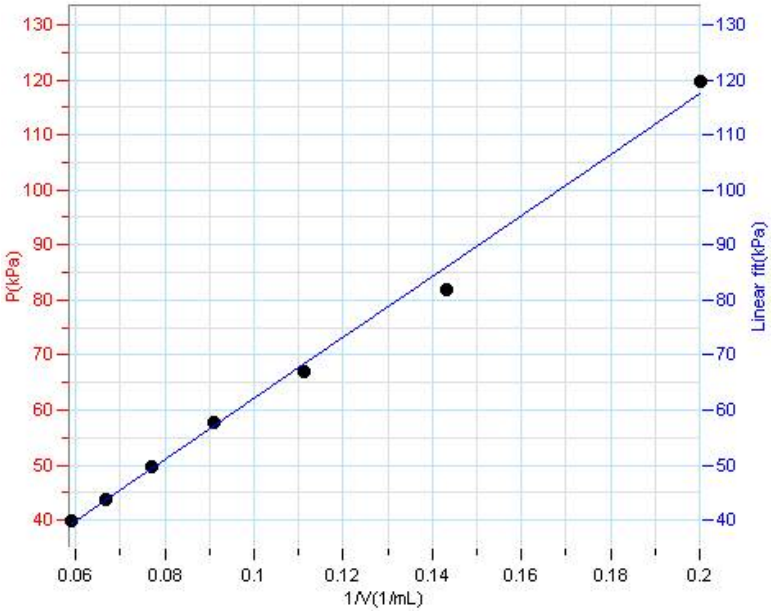
vi) In the **Name** edit box enter a name (e.g. 1/V)

vii) Click **OK**

3. Display a graph of the pressure versus 1/V:

i) Click **Edit graph** on the graph toolbar

ii) Select Functions: 1/V in the **X-axis** list and Pressure I/O-1 in the **Y-axis** list, then click **OK**



4. Apply a linear fit to the graph:

i) Click **Linear fit**  on the main toolbar. The fit equation will be displayed in the information bar at the bottom of the graph window

ii) The slope of the fit line is the product of the number of moles, the temperature and the Gas Constant