OBJECTIVES

1. To describe the application concept of Boyle's Law.
2. To determine the relationship between the pressure and volume of a confined gas.
3. To learn about the planning of a measurement series, the reading of measurement results and the conversion of measurements into a statement of theoretical principle.

LEARNING OUTCOMES

At the end of this laboratory session, students should be able to:

1. Understand the principle of Boyle's Law.
2. Describe the relationship between p and V according to Boyle's Law.

THEORY

Boyle's Law, which states that for a fixed mass of gas at a constant temperature:

$$pV = const \tag{1}$$

This is also known as the isothermal gas law for an ideal gas.
Diagrammatic representation of the law, $pV = const$ shows a hyperbolic curve.

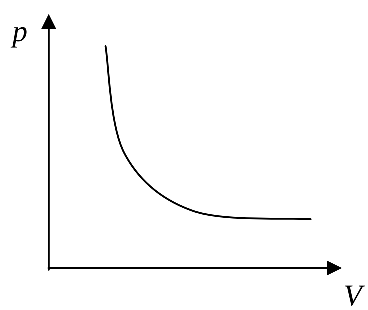

Figure 1- p-V Diagram for Boyle's Law.

APPARATUS

WL100 Apparatus for Demonstrating Boyle's Law

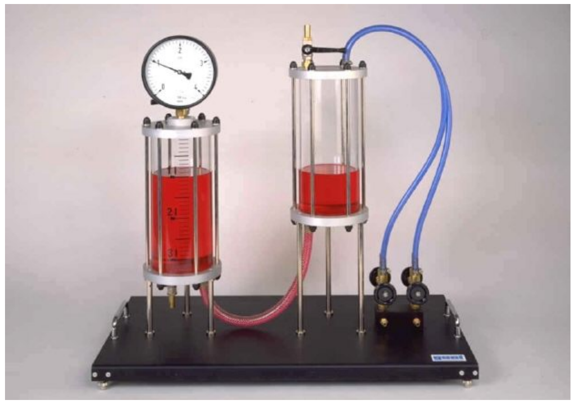

Figure 2 - WL100 Apparatus.

PROCEDURES

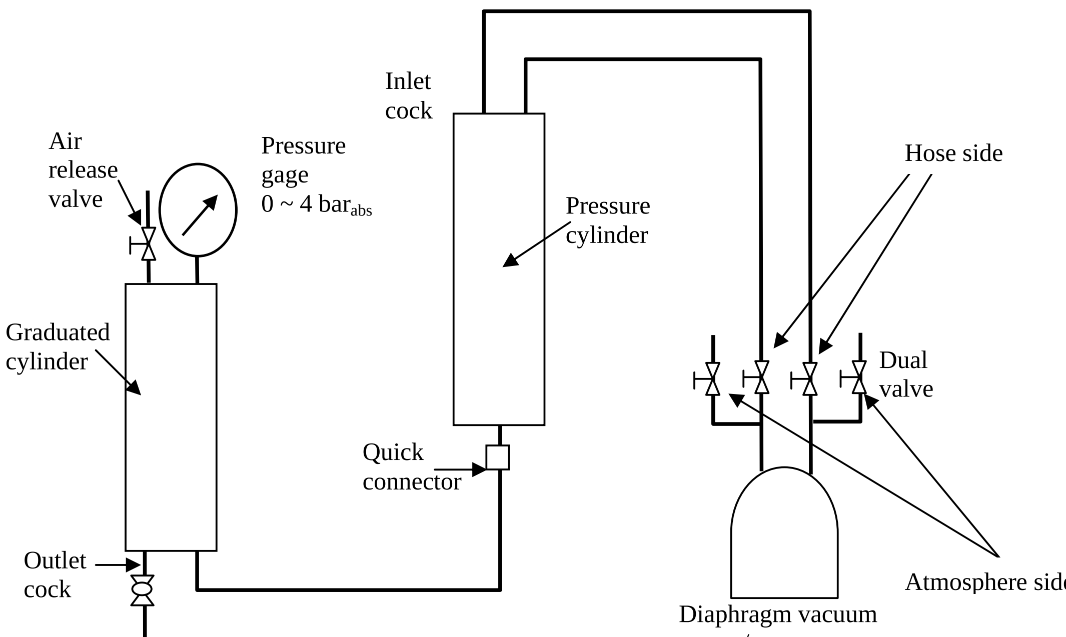

Figure 3 - Schematic Diagram For Boyle's Law Apparatus

Securing the Measured Quantities

Warning: Maximum running time of the pump is 5minutes.

Compression Operation (1.0 L – 0.3 L)

1. Dual valve, compression side **(red ring)**
   - Hose side closed
   - Atmosphere side closed

   Dual valve, suction side
   - Hose side closed
   - Atmosphere side opened

   (a) Turn on the pump.
   (b) Slowly open the compression valve (hose side) and close firmly when the test point reached (volume air 0.9 L).
   (c) Read and record quantities of pressure in Table 1 when the level of water remains steady.

2. Follow the procedure as step (b) to (c) for test point (0.8 L – 0.3 L).

3. Turn off the pump.

4. Open the dual valve compression side and suction side.

Vacuum Operation (1.0 L – 2.0 L)

1. Dual valve, compression side **(red ring)**
   - Hose side closed
   - Atmosphere side opened

   Dual valve, suction side
   - Hose side closed
   - Atmosphere side closed

   (a) Turn on the pump.
   (b) Slowly open the suction valve (hose side); close firmly when the test point (volume air 1.1 L).
   (c) Read and record quantities of pressure in Table 1 when the level of water remains steady.

2. Follow the procedure as step (b) to (c) for test point (1.2 L – 2.0 L).

3. Turn off the pump.

4. Open the dual valve compression side and suction side

5. Switch off the main switch.

NOTES:

AFTER THE DATA HAS BEEN TAKEN, LEAVE THE DUAL VALVE COMPRESSION SIDE AND SUCTION SIDE OPEN.

Name: ______________________________ **Metric Number:** ________________

Section / Group: ______________________ **Date of experiment:** _____________

EXPERIMENTAL DATA

Record the readings into the Table 1 shown below.
Notes: For Informal report, the maximum volume for vaccum operation is 2 litre.

Table 1 - Measurement data

V (litre)	p_{abs} (bar)	$p \times V$ (litre.bar) [X]	Absolute deviance from mean [X – Y] (litre.bar)	Relative deviance from mean (%) [$\frac{X-Y}{Y}$ x 100]
0.3				
0.4				
0.5				
0.6				
0.7				
0.8				
0.9				
1.0				
1.1				
1.2				
1.3				
1.4				
1.5				
1.6				
1.7				
1.8				
1.9				
2.0				
		Mean [Y] =		Mean =

Plot a graph for p versus V

Plot a graph for p versus $1/V$ **(NOT REQUIRED FOR INFORMAL REPORT).**

DISCUSSION

1. If the relationship between p and V is an inverse relationship, the plot of p versus $1/V$ should be direct; that is, the curve should be linear and pass through (or near) the origin. Examine your graph to see if this is true for your data **(NOT REQUIRED FOR INFORMAL REPORT).**

2. By applying the universal gas equation,

   $$p{\cdot}V = m{\cdot}R{\cdot}T$$

   use the measurement data to determine the universal gas constant R.
   Density, ρ of air at room temperature is 1.29 kg/m and 1 kmol of air has a mass of 29 kg. Room temperature should be measured or you can use the value of 21 °C. Units of R should be in Joules/kmol/Kelvin. *Hint:* You must convert mass, m (in grams) into units of kmol using the relationship between a kmol of air and its mass given above.

3. Describe the relationship between p and V according to Boyle's Law.

4. When the properties of gas do not apply the Boyle's Law?

5. What are possible sources of error or limitations in this experiment? For each one, try to decide what effect it might have on the experimental results.

6. Based on your data for this experiment, are pressure and volume directly or inversely proportional? How does this compare with Boyle's Law?

CONCLUSION

State your conclusion of the experiment.