

Unit B – Practical 5

Gas laws – Simulation experiments

Safety

There are no safety issues concerning this experiment.

Apparatus and materials

- laptop with internet access

Introduction

In this simulation experiment you will verify the gas laws.

Boyle's law: for a given mass of gas kept at constant temperature

$$PV = \text{constant} \quad \text{or} \quad P \propto \frac{1}{V}$$

Charles' law: for a given mass of gas under constant pressure

$$\frac{V}{T} = \text{constant} \quad \text{or} \quad V \propto T$$

Pressure law: for a given mass and volume of gas

$$\frac{P}{T} = \text{constant} \quad \text{or} \quad P \propto T$$

Procedure

- 1 Go to the phet website and download the 'Gas properties' simulation (<http://phet.colorado.edu/en/simulation/gas-properties>)
- 2 On the right-hand menu click the 'Measurement Tools >>' control box and tick the 'Ruler'. Align the movable edge of the vessel to the 1 nm mark on the ruler. Use the ruler to measure the dimensions of the container and calculate its volume.
- 3 Pump some gas into the vessel (push the full length of the handle of the pump only once) and wait a few seconds.

Boyle's law

- 4 On the right-hand menu on the top check the 'Temperature' option to keep it constant. Record the values of the volume and pressure.
- 5 Decrease the volume of the vessel by moving the movable edge by 1 nm. Wait for a few seconds and measure the pressure. Calculate the new volume of the container. Record your measurements in a suitable table.
- 6 Repeat step 5 four more times.
- 7 Plot a graph of pressure against volume. Answer question 1.

Charles' law

- 8** First check the 'None' option on the right-hand menu on the top and then press 'Reset'. Pump the handle to insert some gas in the vessel and wait a few seconds.
- 9** On the right-hand menu on the top check the 'Pressure' option to keep it constant. Record the values of the volume and temperature.
- 10** Increase the temperature by approximately 10K. Wait for a few seconds and measure the volume of the vessel. Record the exact value of the temperature and your measurements of the volume in a suitable table.
- 11** Repeat step **10** four more times.
- 12** Plot a graph of volume against temperature. Answer question **2**.

Pressure law

- 13** Press 'Reset' and pump the handle to insert some gas in the vessel and wait a few seconds.
- 14** On the right-hand menu on the top check the 'Volume' option to keep it constant. Record the values of the pressure and temperature.
- 15** Increase the temperature by 10K. Wait for a few seconds and measure the pressure. Record your measurements in a suitable table.
- 16** Repeat step **15** four more times.
- 17** Plot a graph of pressure against temperature. Answer question **c**.

Questions

1 Questions on Boyle's law simulation experiment:

- a** What is the shape of the line and what relationship does it represent?

Does this confirm Boyle's law?

- b** What axes should you use to get a linear graph?

- c** What happens if you try to reduce the volume further?

2 Question on Charles' law simulation experiment:

What is the shape of the line and what relationship does it represent?

Does this confirm Charles' law?

3 Questions on Pressure law simulation experiment:

- a** What is the shape of the line? What relationship does it represent?

Does this confirm the Pressure law?

- b** If you extrapolate the line until pressure is zero, what is this value of temperature?