Unit B – Practical 4

Charles' law

Safety

Avoid contact with hot surfaces.

Apparatus and materials

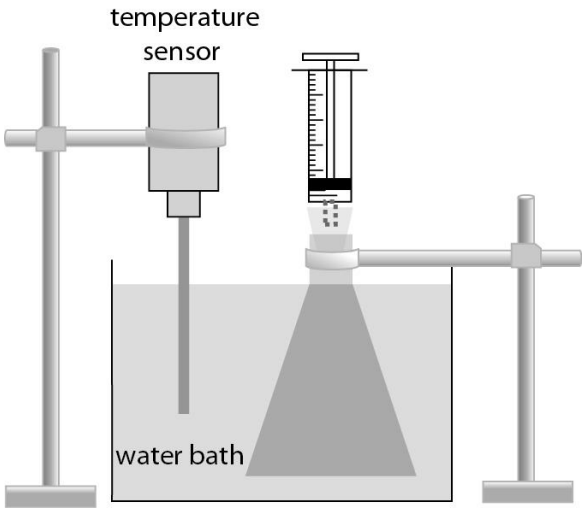
- conical flask
- rubber stopper with hole
- syringe
- water bath
- water
- temperature sensor
- stand and clamp (× 2)

Introduction

Charles' law is the relationship between the volume of a gas and its absolute temperature for a given mass of gas kept at constant pressure. It states that the volume of the gas V is proportional to its absolute temperature T and can be expressed as:

$$\frac{V}{T} = \text{constant} \quad \text{or} \quad \frac{V_1}{T_1} = \frac{V_2}{T_2}$$

It is equivalent to the ideal gas law $PV = RnT$ (n = number of moles of gas, R = gas constant, P = pressure of gas) when n and P are constant.



Procedure

1 To ensure that no air will leak, cover the piston seal of the syringe with a small amount of lubricant as well as the connections of the rubber stopper with the syringe and the conical flask.

2 Place the piston at the lowest mark and insert into the rubber stopper. Then seal the conical flask with this rubber stopper.

3 Immerse the flask in a water bath. Use a clamp and stand to keep most of the volume of the flask submerged.

4 Place a temperature sensor in the water bath and secure its position with a clamp and stand.

5 Set the temperature of the water bath to 30°C. Monitor the temperature of the water with the temperature sensor. When the water has reached the desired temperature allow some time for the air in the syringe to reach the same temperature.

6 To take a reading of the volume, twist the piston and push slightly. Allow it to reach its rest position and then take the reading. Record your measurements.

7 Increase the temperature of the water bath and repeat steps **5** and **6**.

8 Repeat the process for three more temperatures. (Note: Do not heat water above 80°C.)

9 Plot a graph of volume *V* against **absolute** temperature *T*.

Questions

1 What is the shape of your graph? What relationship between volume and temperature does this shape represent?

2 What effect would it have on your graph if you did not use the temperature in kelvin but in degrees centigrade?

