

Experiment 5a

Ideal Gas Law

1 Introduction

The ideal gas law relates the pressure P , volume V , and temperature T of an ideal gas via

$$PV = NkT$$

where k is Boltzmann's constant and N is the number of molecules. The temperature is measured on the absolute Kelvin scale. In this experiment, we will measure the pressure vs. temperature, for constant volume.

2 Procedure

1. Set up the absolute pressure and the temperature sensors in Capstone. Set the sampling to "KEEP MODE" (see below for details).
2. Put ice and cold water in the white plastic percolator. Use just enough ice to have a little ice left in the water.
3. Mount the chamber on a wooden paint-stirrer with rubber bands. Bind the rubber cork to the chamber with rubber bands. The chamber is then connected to the pressure sensor. (It is not necessary to use the cylinder/piston apparatus for this experiment.)
4. Put the temperature sensor into the percolator. You may want to bind the temperature sensor to the chamber also. Put the chamber in the percolator and stir gently. Start the manual data-taking. A click is required for each data point. This is done by changing the sample mode from CONTINUOUS to KEEP MODE. In this mode, CAPSTONE will allow you to take data for several selected values of volume. Hit PREVIEW and watch the data point populate the graph or table. Click KEEP SAMPLE.
5. Once you have a few points in the ice water, turn on the percolator. Stir continually and take data points.

You may want to turn off the percolator occasionally so that it does not heat the water too fast. The reason for this is that it is important that the gas and the water be at the same temperature. If the heating is too fast, the gas will not have "caught up" with the water.

6. Continue stirring, heating and data-taking. At a temperature of about 70 degrees Celsius, it is likely that the cork will pop off. Stop data-taking when this happens by clicking STOP.
7. With the data, make a plot of pressure (vertical axis) vs. temperature (horizontal axis.) You may use either Capstone, or put the data into a spreadsheet. It is important to note that this can be done in a TABLE instead of a graph. The tabulated data can be exported to excel for analysis by first highlighting it—remember to highlight both columns—and then right click on it and select COPY. Then open EXCEL and right click any cell and select PASTE. Make the horizontal axis extend far enough to accommodate absolute zero (-273 C). Make sure the vertical scale extends to zero pressure.
8. Determine the straight line which best fits your data. At what temperature does the pressure become zero? Compare this with the value of absolute zero.