College Physics I

Lab 9: Absolute Zero

Peter Rolnick and Taner Edis

Absolute Temperature

Pretend it is a few hundred years ago, and you are not familiar with the Absolute (Kelvin) temperature scale. However, you are familiar with the Celsius scale, defined such that at standard atmospheric pressure, water freezes at 0°C and water boils at 100°C.

Your mission, in this lab, is to discover absolute zero; in other words, the Celsius temperature at which the pressure of an ideal gas is zero. There is no way you can approach such a temperature in our lab, so you will have to extrapolate from whatever data you can gather. You will need to take a fixed amount of a gas and note the pressure at different temperatures. If you graph pressure versus temperature, and if it approximates a straight line, then you can extrapolate the line until it reaches zero pressure, and read off the graph what the Celsius temperature is at that point.

Part 1: Take data

There will be a number of different baths provided in the lab. In each of them, you will have water or ice at varying temperatures. You will use a thermometer at each station to get as precise a reading of the temperature of each bath as possible. You will be given an apparatus filled with a fixed amount of gas at a fixed volume, though pressure will be allowed to vary with temperature. Then you will take data: temperature of the bath and pressure of the gas—we are assuming that the temperature of the gas is equal to the temperature of the bath—at each of the three baths. You will do this for two different gases or mixtures of gases.

If you do not leave the apparatus in the bath long enough, the gas in the apparatus will not have reached the temperature of the bath. Watch that the pressure gauge has stopped changing before you take data, and be sure to take your temperature reading and your pressure reading at the same moment. In addition, stir the bath to insure that one part of the bath is not at a different temperature than another part.

To hand in for part 1

All data collected.

Part 2: Graph and interpret your data

For each gas or mixture of gases, make a graph of pressure versus temperature. Extrapolate the graph to zero pressure and make an estimate of the Celsius temperature at absolute zero.

Things to think about: Does your result from one gas agree with the result from the other? Should it? Is the slope of your graph from one gas the same as that from the other? Should it be? Is it reasonable to consider the gases used in this experiment as ideal gases? As you think about these rhetorical questions, use the model of an ideal gas, $PV = nRT$, as a starting point. Make an estimate of the number of moles of gas in the apparatus for each of the gases (or mixtures of gases) you studied.

To hand in for part 2

- A plot of pressure versus temperature and a result for absolute zero for each gas or mixture of gases, all on the same graph.
- Your estimate of the number of moles in the apparatus for each gas or mixture of gases, with a brief explanation of how you arrived at that estimate.