

# CHEM 360 L

## EXPERIMENT 1

### Molecular Weight Determination by Gas Density Measurement

#### Introduction

This experiment shows how one determines the molecular weight of a gas from measurements of mass, volume, and pressure. The student will perform these measurements on air and a pure gas. One form of the ideal gas law is:

$$PV = gRT/M$$

where P is the pressure, V the volume, T temperature, g the mass of the gas sample, and M the molar mass of the gas. This equation is valid at low pressures, so the measurements of M are made at a variety of pressures, then extrapolated back to zero pressure. The pressure will be measured using an open end mercury manometer, the volume measured by filling the bulb with water and measuring the mass of the contained water.

#### Procedure

The instructor will show you how to set up the filling/evacuation system for this experiment. A bulb is selected, the stopcock and inlet slightly greased (note that the variation in greasing the bulb may contribute to errors in the experiment). The bulb is evacuated and weighed (all weighings for this experiment should be done in triplicate). Make sure that the system is leak-tight. Air is admitted to the bulb through a drying tube (pressure between 0.1 and 1.0 atm), the stopcock closed, noting the pressure in the system at this time. The pressure is the difference between the mercury levels in the two arms of the manometer, subtracted from the atmospheric pressure. The bulb is then removed from the system and weighed with the sample of air. This procedure should be repeated for four different pressures. Note the temperature at the time (and location) of filling and at the time (and location) of weighing. The gas source is then changed to a cylinder of a pure gas. Four measurements of pressure and mass should be made for the gas, as was done above (you will not need the drying tube). After all of the gas readings have been made, the bulb is filled completely with water. The best way to do this is to evacuate the bulb, then immerse the inlet in a large beaker of distilled water. If air bubbles remain, a syringe may be used to fill the bulb the rest of the way. The filled bulb is then weighed (in triplicate), and the volume determined from the density of water at the temperature of the weighing. The bulb is then emptied, disassembled, cleaned, and placed in the ovens for drying.

#### Calculations

The weight of the gas is determined by difference. Equation (1) may be rearranged to

$$M = gRT/PV$$

For each gas, the measured weight is listed in a table with the appropriate temperature, volume, and pressure measurements. A plot of  $M$  vs.  $P$  should be shown, with a least-squares linear regression used to obtain a fit to the data. The molecular weight is determined by extrapolating the regression line to zero pressure.