Problem Set 7: Density and the Ideal Gas Law, Partial Pressures

HCHE 111L: Introduction to Elementary Inorganic Chemistry

Due Date: Friday October 13$^{\text{th}}$, 2017

Problem 1

Dry air is a mixture of different gases (primarily O_2 and N_2) with an effective molar mass of 29.0 g mol^{-1}

a) Compute the density of dry air on a July day when the temperature is 95.0°F and the pressure is 1.00 atm.

b) Compute the density of dry air on an October evening when the temperature is 50.0°F and the pressure is 1.00 atm.

Problem 2

A gas has a density of 2.94 g L^{-1} at 50°C and P= 1.00 atm.

a) Calculate the molar mass of the gas assuming it obeys the ideal gas law

b) What will be its density at 150°C?

Problem 3

A gas mixture at room temperature contains 10.0 mol of CO and 12.5 mol of O_2.

a) Compute the mole fraction of CO in the mixture

b) The total pressure of the gas is 2.6 bar. Calculate the partial pressure of CO in the mixture

Problem 4

A gas mixture contains 4.5 mol Br_2 and 33.1 mol F_2.

a) Compute the mole fraction of Br_2 in the mixture

b) The total pressure of the gas is 5.0 bar. Calculate the partial pressure of Br_2 in the mixture.

Problem 5

One of the chemical controversies of the nineteenth century concerned the element beryllium (Be). The debate centered around whether beryllium naturally reacted with two ions (divalent) or three ions (trivalent). In 1894, an experiment was done to test this. In the experiment beryllium was reacted with the anion $C_5H_7O_2{}^-$ and measured the density of the gaseous product. Two experiments were performed and the following data was collected:

	I	II
Mass	0.2022 g	0.2224 g
Volume	22.6 cm^3	26.0 cm^3
Temperature	13°C	17°C
Pressure	765.2 mmHg	764.6 mmHg

If berylium is a divalent metal, the molecular formula of the product will be $Be(C_5H_7O_2)_2$. If it is trivalent, the formula will be $Be(C_5H_7O_2)_3$. Show how this experiments data helps to confirm that beryllium is a divalent metal.

Problem 6

When a gas is cooled at constant pressure, it is found that the volume decreases linearly:

$$V = 209.4\text{L} + \left(0.456 \frac{\text{L}}{^\circ F}\right) \times T_F$$

where T_F is the temperature in degrees Fahrenheit and L is simply specifying the units is liters. From this relationship, estimate the absolute zero of temperature in degrees Fahrenheit. [To figure out this problem think back to our discussion in class about absolute zero (0 K), how was it determined to be -273.15°C?]