Worksheet 2

January 11, 2022

Weekly homework assignments are posted approximately one week prior to the due date. Collaborations are encouraged and students must report all collaborators in writing on each assignment. All external sources (websites, books) must be properly cited. Additional problems are listed at the end of each assignment. This week's assignment is due *Tuesday, Jan 18th at 10:00am.*

Ideal Gas Law

1. (2 pts) What is the density (in g/L) of chloroform, $CHCl_3$, vapor at 2.00×10^2Torr and 298K. Report to 3 significant figures.

2. (2 pts) A compound used in the manufacture of Saran is 24.7% C, 2.10% H, and 73.2% Cl by mass. The storage of 3.557g of the gaseous compound in a 755-mL vessel at 0°C results in a pressure of 1.10atm. What is the molecular formula of the compound? Report to 3 significant figures.

3. (2 pts) A vessel of volume 22.4L contains 2.00 mol H_2(g) and 1.00 mol N_2(g) at 273.15K. Calculate the partial pressures and the total pressure. Report to 3 significant figures.

4. (6 pts) A flask of volume 5.00L is evacuated and 43.78g of solid dinitrogen tetroxide, N_2O_4, is introduced at $-196°C$. The sample is then warmed to 25°C, during which time the N_2O_4 vaporizes and some of it dissociates to form brown NO_2 gas. The pressure slowly increases until it stabilizes at 2.96atm. Report to 3 significant figures.

(a) Write a balanced equation for the reaction.

(b) If the gas in the flask at 25°C were all N_2O_4, what would the pressure be?

(c) If all the gas in the flask converted into NO_2, what would the pressure be?

(d) What are the mole fractions of N_2O_4 and NO_2 once the pressure stabilizes at 2.96atm?

5. (6 pts) **Barometric Formula** The barometric formula is a model that predicts the changes of air pressure depending on the altitude. This formula assumes ideal gas conditions at constant temperature T. Derive the barometric formula.

(a) Draw a free body diagram of a volume of air. Define all variables. *Hint:* The net force equals zero.

(b) Invoke the ideal gas law to replace variables in terms of pressure, temperature, and volume.

(c) Solve for pressure and integrate.

First Law of Thermodynamics

6. (4 pts) Calculate the work for each of the following processes beginning with a gas sample in a piston assembly with $T = 305\text{K}$, $P = 1.79\text{atm}$, and $V = 52.9\text{L}$ by two different pathways. Report to 3 significant figures.

(a) Isothermal, reversible expansion to a final volume of 6.52L.

(b) Irreversible expansion against a constant external pressure of 1.00atm to a final volume of 6.52L.

Optional Additional Problems: Ch. 10 - odd problems 95 - 117