Worksheet 8 on Chapter 4: Gases

I. Gas Laws

1. A sample of oxygen gas at 30°C fills a 50 L volume. If the temperature is raised to 50°C and the pressure is held constant, what volume will the same sample occupy?

$\frac{V_1}{T_1} = \frac{V_2}{T_2}$ $\frac{50\,ml}{303} = \frac{V_2}{323} = 53.3\,ml$

2. What is the density of a gas if 0.036 moles of it occupy 3 L and its molecular weight is 75 g/mol?

$.9\,g/L = \rho = \frac{g}{L} = \frac{2.75}{3}$ $n = \frac{g}{MW}$ so $n = .036 = \frac{g}{75}$ $g = 2.75$

3. Under a pressure of 1.7 atm, a N_2 sample occupies 35 mL. If the temperature does not change, at what pressure will the sample occupy 20 mL?

$P_1V_1 = P_2V_2$

$(1.7\,atm)(.035\,l) = ?P\,(.020\,l)$ $P = 2.975$ atm

4. Calculate the volume of CO_2 at 25 °C and 1 atm that plants need to make 1 gram of glucose ($C_6H_{12}O_6$) by photosynthesis, assuming the reaction: $6CO_2 + 6\,H_2O \rightarrow C_6H_{12}O_6 + 6\,O_2$

$.8\,l = V = \frac{nRT}{P} = n\frac{(.082)(298)}{1\,atm}$ $\frac{6}{180}$ $n_{CO_2} = 1\,g\,glucose\left(\frac{mole}{180\,g}\right)\left(\frac{6\,mole\,CO_2}{1\,mole\,glucose}\right)$

5. 5.0 mol of a gas with a density of 1.23 g/L take up 10.0 L. What is its molecular weight?

$\rho = 1.23\,g/L = \frac{g}{L} = \frac{g}{10\,L}$ so $g = 12.3\,g$ $5\,mole = \frac{12.3\,g}{MW}$

6. Given that a gas is at 1 atm, 273 K, and takes up 2.5 L, how many molecules of the gas are present?

$n = \frac{PV}{RT} = \frac{(1)(2.5)}{(.082)(273)} = 0.11\,mole$

$(.011\,moles)\left(\frac{6.02\times10^{23}}{mole}\right) = 6.7\times10^{22}$ molecules

II. Kinetic Molecular Theory

Indicate whether, according to kinetic molecular theory, the statement is true (T) or false (F).

1. When gas molecules collide with their container, they transfer energy to it that is proportional to their velocity. T (F)

2. Gas molecules of different compounds have the same average kinetic energy at the same temperature. (T) F

3. Gas molecules of different compounds have the same average velocity at the same temperature. T (F)

4. When two gas molecules collide, they don't usually form a new compound. (T) F

5. Gas molecules aren't very attracted to one another under standard conditions. (T) F

6. A pure sample of gas molecules will have the same average kinetic energy at all temperatures and pressures. T (F)

7. The average kinetic energy of a gas molecule depends on both the surrounding temperature and the molecular weight. T (F)

III. Diffusion/Effusion

1. The larger the gas molecule, the slower the rate of its diffusion. (T) F

2. A smell spreading through a room is an example of effusion. T (F)

3. Rates of diffusion depend on the molecular weight of the gas. (T) F

IV. Velocities of Gases

Calculate the average velocities of the molecules in the following gases and put them in order from slowest to fastest.

(a) CO_2

(b) He

(c) N_2

(d) C_2H_2

don't bother with absolute velocities, but can find from $kT = E = \frac{1}{2}mv^2$ but be able to solve relative velocity from $m_1v_1^2 = m_2v_2^2$

$CO_2 < N_2 < C_2H_2 < He$

Ranking: slowest → fastest

smaller are faster

V. Non-ideal Gases

1. Why would the ideal gas law be a better approximation for N_2 gas and Ne gas than for CH_3OH gas?

CH_3OH has H bonding so large a term in Vanderwaals

2. Using the non-ideal gas equation, $(P + n^2a/V^2)(V-nb) = nRT$, what would be the exact volume of 1.0 mol of H_2 gas at 273 K and 1.0 atm, given that the non-ideal corrections for H_2 are a=0.244 and b=0.266?

yikes, a cubic, make Minh Nam solve this.