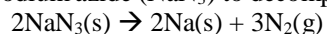


Chapter 5 Homework

Answer each of the following questions clearly. Show all work when necessary. 18 points.

1. Calculate the pressure exerted by 56.0 grams of N_2 in a 20.00 L container at $-85^\circ C$.
 - a. Using the ideal gas law. (1 pt)
 - b. Using the van der Waals equation ($a = 1.39$; $b = 0.0391$) (1 pt)
 - c. Many gases deviate from "ideal" behavior at low temperatures and high pressures. As a result you should use your pressure result from part b. If the volume is held constant, and the temperature rises to $-5.0^\circ C$, what would be the pressure exerted by the nitrogen gas? (1 pt)

2. Air bags are activated when a severe impact causes a steel ball to compress a spring and electrically ignite a detonator cap. This causes sodium azide (NaN_3) to decompose explosively according to the following reaction:



- a. What mass of $NaN_3(s)$ must be reacted to inflate an air bag to 70.0 L at a pressure of 733 mm Hg and a temperature of $-35.00^\circ C$? (1 pt)
- b. What is the density of nitrogen gas at this temperature? (1 pt)
- c. How many molecules of nitrogen are present in the volume of gases calculated in part A? (1 pt)
- d. What is the mass of nitrogen actually produced at the above conditions? (1 pt)

3. A mixture of oxygen, O_2 , and nitrogen, N_2 has a total pressure of 745 mm Hg at $15^\circ C$ and contains 8.20 grams of each substance.
- Calculate the partial pressure of each gas in the mixture. (2 pts)
 - Calculate the root mean square velocity of each gas at $15^\circ C$. (2 pts)
 - Determine the density of each gas at the above conditions. (2 pts)
 - Determine the volume of each gas at the above conditions. (2 pts)
 - If it is determined that it takes oxygen, (O_2) 41 seconds to completely effuse. How long does it take nitrogen, (N_2) at the above conditions? (1 pt)

4. One of the chemical controversies of the 19th century concerned the element beryllium (Be). Berzelius originally claimed that beryllium was a trivalent element (Be^{3+}) and it gave an oxide with the formula Be_2O_3 . This resulted in a calculated atomic mass of 13.5 for beryllium. In formulating his periodic table, Mendeleev proposed that beryllium was divalent (Be^{2+}) and it gave an oxide with the formula BeO . This assumption gives an atomic mass of 9.0. In 1894 A. Combes (*Comptes Rendus* 1894, p. 1221) reacted beryllium with the anion $C_5H_7O_2^-$ and measured the density of the gaseous product. Combes's data for two different experiments are as follows:

	Test 1	Test 2
Mass	0.2022 g	0.2224 g
Volume	22.6 cm^3	26.0 cm^3
Temperature	$13^\circ C$	$17^\circ C$
Pressure	765.2 mm Hg	764.6 mm Hg

If beryllium 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 Combes's data help to confirm that beryllium is a divalent metal. You must show calculations and give a brief statement explaining your answer. (2 pts)

Gas Law Formulas	
$P_{\text{total}} = P_1 + P_2 + P_3 \dots$	Dalton's Law of Partial Pressure
$X_1 = n_1/n_{\text{total}} = P_1/P_{\text{total}}$	Mole Fraction
$P_1V_1 = P_2V_2$	Boyle's Law
$V_1/T_1 = V_2/T_2$	Charles' Law
$V_1/n_1 = V_2/n_2$	Avogadro's Law
$P_1/T_1 = P_2/T_2$	Gay-Lussac's Law
$P_1V_1/T_1 = P_2V_2/T_2$	Combined Gas Law
$\frac{\text{Rate}_B}{\text{Rate}_A} = \frac{\sqrt{MM_A}}{\sqrt{MM_B}}$	Graham's Law
$PV = nRT$ R = 8.3145 L kPa/mol K or R = 0.08206 L atm/mol K	Ideal Gas Law
(mm) P = dRT mm = molar mass d = density R = 0.08206 L atm/mol K	Gas Density/Molar Mass
$v_{\text{rms}} = \sqrt{3RT/M}$ M = molar mass in kg/mol R = 8.3145 J/mol K	Root Mean Square Velocity
$[P_{\text{obs}} + a(n/V)^2] \times (V - nb) = nRT$	van der Waals Equation
Standard Atmospheric Pressure: 1 atm = 760 torr = 760 mm Hg = 101.3 kPa = 14.7 psi	