CHM 1010 **REVIEW PROBLEMS BASED ON GAS LAWS I** **Gage**

1. A sample of nitrogen has a volume of 460 mL at 50°C and 800 mmHg. What is its volume at STP?

$P_1 = 800$ mmHg $V_1 = 460$ mL $T_1 = 50°C = 323K$

$P_2 = 760$ mmHg $V_2 = ?$ mL $T_2 = 0°C = 273K$

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2} \quad \frac{P_1V_1T_2}{T_1P_2} = V_2 = \frac{(800\text{ mmHg})(460\text{ mL})(273K)}{(323K)(760\text{mmHg})} = 409\text{ mL}$$

2. What is the molar mass of a gas if the volume of a 0.568 g sample is 143 mL at 35°C and 950 torr?

$$PV = \frac{gRT}{MM} \text{ so } MM = \frac{gRT}{PV} \quad \frac{(0.568g)(0.0821\text{L atm})(308K)}{(1.25\text{ atm})(\text{mol K})(0.143L)} = 80.4\text{g/mol}$$

3. A helium tank has a volume of 522 L at 22°C and 151 atm. What is the volume at 22°C and 760 mmHg?

$P_1 = 151$ atm $V_1 = 522$ L ~~$T_1 = 22°C = 295K$~~

$P_2 = 1.00$ atm $V_2 = ?$ L ~~$T_2 = 22°C = 295K$~~

$$\frac{P_1V_1}{} = \frac{P_2V_2}{} \quad \frac{P_1V_1}{P_2} = V_2 = \frac{(151\text{ atm})(522\text{ L})}{(1.00\text{ atm})} = 7.88 \times 10^4\text{ L}$$

4. What is the pressure of a gas at 200°C if its pressure is 1600 mmHg at 400°C?

$P_1 = 1600$ mmHg $V_1 = ?$ mL $T_1 = 400°C = 673K$

$P_2 = ?$ mmHg $V_2 = ?$ mL $T_2 = 200°C = 473K$

$$\frac{P_1}{T_1} = \frac{P_2}{T_2} \quad \frac{P_1T_2}{T_1} = P_2 = \frac{(1600\text{ mmHg})(473K)}{(673K)} = 1.12 \times 10^3\text{ mmHg}$$

5. How many liters of chlorine gas at 25°C and 1.88 atm are needed to react with 12.0 grams of phosphorus according to the following reaction?

$$P_4\,(s) + 6\,Cl_2\,(g) \text{ ------> } 4\,PCl_3$$

$$12.0\text{ g } P_4 \times \frac{1\text{ mol } P_4}{124.0\text{ g } P_4} \times \frac{6\text{ mol } Cl_2}{1\text{ mol } P_4} = 0.581\text{ mol } Cl_2$$

$$PV = nRT \quad V = \frac{nRT}{P} = \frac{(0.581\text{ mol})(0.0821\text{L atm})(298K)}{(1.88\text{ atm})\,(\text{mol K})} = 7.56\text{ L}$$

6. What is the density of sulfur hexafluoride at 90°C and 850 torr?

$$PV = \frac{gRT}{MM} \quad \frac{P\,MM}{RT} = \frac{g}{V} = D = \frac{(1.12\text{ atm})(146.1\text{ g/mol})}{(0.0821\text{ L atm/mol K})(363K)} = 5.49\text{ g/L}$$

7. If you were standing 10 yards away from a person and he simultaneously opened two

containers with hydrogen sulfide (rotten egg odor) and dinitrogen oxide (laughing gas), which would you detect first and why?
MM of H_2S = 34.1 g/mol MM of N_2O = 44.0 g/mol
Since particles with a lower mass diffuse faster with the same energy (at same temperature), the hydrogen sulfide will arrive first so you will smell rotten eggs.

8. A gas mixture has a total pressure of 2.35 atm and is 46% ammonia. What is the pressure of the ammonia in the mixture?
2.35 atm x 0.46 = 1.1 atm of NH_3

9. The box below has a semipermeable membrane that allows gases to flow across from one side of the box to the other. The values represent partial pressures of gases that are put into the box on each side of the membrane. In the second box, write the values of each components after the system has had a chance to equilibrate. Indicate the total pressures for each part of both systems.

200 mm N_2	150 mm N_2	175 mmHg N_2
75 mm O_2	175 mm O_2	125 mmHg O_2
380 mm CO_2	380 mm CO_2	380 mmHg CO_2
500 mm Ar	530 mm Ar	515 mmHg Ar

11. Answer each of the following using the relationships between gas variables:
a. Why does hot air rise?
As gases heat up their volume increases (pressure remains the same on average). Since the mass is the same but the volume is lower, the density is lower. Less dense materials float on denser materials so it will rise above the cooler air.
b. Why do aerosol cans have the warning, ADo not incinerate=?
As the temperature increases, the gas particles inside the can begin to move faster, making more collisions with the walls of the container. Since aerosol cans have a set volume, the pressure increases rather than the volume. When the pressure in the can exceeds the pressure limits of the seam, the can will explode.
c. Explain 2 ways to decrease the volume of a sealed balloon without manually squeezing it.
Increase the pressure surrounding the balloon; chill the balloon so that volume decreases.
d. Explain why your car tires look more inflated after a long road trip than they do first thing in the morning.

12. Explain why you will eventually smell a person's perfume or aftershave even though she or he is sitting some distance from you.
Gas particles are always in random, rapid motion. The gaseous perfume molecules will move away from the source, mixing with the air molecules and eventually traveling to you.
13. Explain when and why gases deviate from ideal behavior.

When a property of a gas is measured and it is not the same as the theoretical value predicted using the Ideal Gas Law, the gas is said to behave non-ideally. This generally occurs when the pressure is very high and the temperature is very low. Under these conditions, gas particles are closer together so attractive or repulsive forces may have an influence and the actual volume of the gas particle becomes significant.