CHM 1010 **Problems Involving Gases II** **Gage**

1. A helium balloon has a volume of 22 L at sea level where the pressure is 0.981 atm on a given day. If the balloon is released it travels to an altitude where the pressure is 550 mmHg before it bursts. What is its volume right before it bursts?

$P_1 = 0.91$ atm $V_1 = 22$ L $T_1 = ?$

$P_2 = 550$ torr $= 0.724$ atm $V_2 = ?$ L $T_2 = ?$

$$P_1V_1 = P_2V_2 \quad \frac{P_1V_1}{P_2} = V_2 = \frac{(0.981\text{ atm})(22\text{ L})}{(0.724\text{ atm})} = 30\text{ L}$$

2. A 100.0 mL flask contains argon at 1.3 atm and 77°C. What is the mass of argon in the flask?

$$PV = \frac{gRT}{MM} \quad \frac{PVMM}{RT} = g = \frac{(1.3\text{ atm})(0.1000\text{ L})(39.9\text{ g/mol})}{(0.0821\text{ Latm/molK})(350\text{ K})} = 0.18\text{ g Ar}$$

3. The pressure in an auto tire is 30 lb/in^2 at 20.0 °C. After several hundred miles of driving the tire pressure is 34 lb/in^2. Assuming a constant volume for the tire, what is the new temperature in °C in the tire?

$P_1 = 30$ psi $V_1 = ?$ $T_1 = 20.0°C = 293$ K

$P_2 = 34$ psi $V_2 = ?$ $T_2 = ?$

$$\frac{P_1}{T_1} = \frac{P_2}{T_2} \quad T_2 = \frac{P_2T_1}{P_1} = \frac{(34\text{ psi})(293\text{ K})}{(30\text{ psi})} = 332\text{ K} = 59°C$$

4. $N_2 + 3\,H_2 \text{ --------> } 2\,NH_3$

How many liters of hydrogen at 25 °C and 950 mmHg are required to react with 55 L of nitrogen at 1500 mmHg and 100 °C?

$$55\text{ L } N_2 \times \frac{3\text{ L } H_2}{1\text{ L } N_2} = 165\text{ L } H_2 \text{ at 1500 mmHg and } 100°C$$

change 165L from 1500 mmHg and 100°C to 950 mmHg and 25°C

$P_1 = 1500$ mmHg $V_1 = 165$ L $T_1 = 100°C = 373$ K

$P_2 = 950$ mmHg $V_2 = ?$ $T_2 = 25°C$

$$\frac{P_1V_1T_2}{T_1P_2} = V_2 = \frac{(1500\text{mmHg})(165\text{L})(298\text{K})}{(373\text{K})(950\text{mmHg})} = 208\text{ L } H_2$$

5. The density of a gaseous compound made from phosphorus is 3.60 g/L at 420 K and 727 mmHg. What is the molar mass of the gas?

$$PV = nRT \quad PV = \frac{g}{MM}RT \text{ so } \frac{P\,MM}{RT} = \frac{g}{V} = D$$

$$MM = \frac{D\,R\,T}{P} = \frac{(3.60\text{ g/L})(0.0821\text{ L atm/mol K})(420\text{ K})}{(0.957\text{ atm})}$$

6. A gas mixture is 35% neon, 45% argon, and 20% krypton. If the total pressure of the gas mixture is 1750 mmHg, what are the partial pressures of the three gases?

$pp_N = 1750 \text{ mmHg} \times 0.35 = 6.1 \times 10^2 \text{ mmHg } N_2$

$pp_{Ar} = 1750 \text{ mmHg} \times 0.45 = 7.9 \times 10^2 \text{ mmHg Ar}$

$pp_{Kr} = 1750 \text{ mmHg} \times 0.20 = 3.5 \times 10^2 \text{ mmHg Kr}$

7. Which of the following samples contains the greatest number of particles?:

a. 5.0 g H_2 b. 50 L of SF_6 at STP

c. 1.0×10^{24} molecules of CO_2 d. 67L of a gas hydrocarbon at STP

$$5.0 \text{ g } H_2 \times \frac{1 \text{ mol } H_2}{2.0 \text{ g } H_2} = 2.5 \text{ mol } H_2$$

$$50 \text{ L } SF_6 \times \frac{1 \text{ mol at STP}}{22.4 \text{ L}} = 2.2 \text{ mol } SF_6$$

$$1.0 \times 10^{24} \text{ molecules } CO_2 \times \frac{1 \text{ mol } CO_2}{6.02 \times 10^{23} \text{ molecules } CO_2} = 1.7 \text{ mol } CO_2$$

$$67 \text{ L} \times \frac{1 \text{ mol at STP}}{22.4 \text{ L}} = 3.0 \text{ mol HC}$$

"d" is highest value

8. Explain why two gases in the same container may exert different pressures while being at the same temperature.

$$PV = nRT \text{ so } P = \frac{nRT}{V}$$

The pressure depends on three variables. Two values (volume and temperature) may be the same but the number of particles (n) may be different.

9. The planet Jupiter has a mass 318 times greater than Earth and its surface temperature is 140 K. Mercury has a mass 0.055 times that of Earth and its surface temperature is between 600 and 700 K. On which planet is an atmosphere more likely to obey the ideal gas law? Explain.

Gases deviate from ideal behavior at high pressures and low temperatures since under these conditions gas molecules are closer together and the chances for interactions (attractions or repulsions) increase. Since Jupiter has the higher pressures and lower temperatures, deviations are more likely to occur there.