**Practice Problems (Chapter 7): Gas Laws**

1. Which gas effuses faster, NH₃ or CCl₄? How much faster does it effuse?

   
   \[
   \text{Rate effusion } \text{NH}_3 = \frac{\sqrt{M_{\text{CCl}_4}}}{\sqrt{M_{\text{NH}_3}}} = \frac{\sqrt{153.81 \text{ g/mol}}}{\sqrt{17.034 \text{ g/mol}}} = \frac{12.402201597}{4.12726672} = 3.004927268
   
   \text{Rate effusion } \text{CCl}_4
   
   \text{Answer: NH}_3 \text{ effuses } 3.005 \text{ times faster than } \text{CCl}_4
   
2. A large balloon filled with helium gas (occupying 293.1 L at 24.8°C and 769.2 torr) is released. What volume (in L) would the balloon occupy when it reaches an altitude where the conditions are –18.7°C and 383.6 torr?

   
   \[
   \frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}
   
   \frac{(769.2 \text{ torr}) (293.1 \text{ L})}{(297.95 \text{ K})} = \frac{(383.6 \text{ torr}) V_2}{(254.45 \text{ K})}
   
   \text{Answer: } 501.9 \text{ L}
   
   V_2 = 501.9212246 \text{ L}
   
3. A gas in a 975 mL cylinder is at 835 torr. If the gas is compressed by a piston to 225 mL, what is the pressure of the gas (in atm)?

   \[
   P_1V_1 = P_2V_2
   
   (835 \text{ torr}) (975 \text{ mL}) = P_2 (225 \text{ mL})
   
   \frac{3618.333333 \text{ torr}}{760 \text{ torr}} = 4.760964912 \text{ atm}
   
   P_2 = 3618.333333 \text{ torr}
   
   \text{Note: You could also convert torr to atm before plugging into Boyle’s Law.}
   
   \text{Answer: } 4.76 \text{ atm}
4. Hydrogen gas is collected over water at 27.0°C and 748.9 torr. If 3.978 L of gas is collected, how many moles of hydrogen are in the container? ($P_{H_2O} = 26.5$ torr at 27.0°C)

\[
P_{total} = P_{H_2} + P_{H_2O}
\]

\[
P_{H_2} = P_{total} - P_{H_2O}
\]

\[
P_{H_2} = 748.9 \text{ torr} - 26.5 \text{ torr}
\]

\[
P_{H_2} = 722.4 \text{ torr}
\]

\[
PV = nRT
\]

\[
\frac{n_{H_2}}{RT} = \frac{P_{H_2}V}{RT} = \frac{(0.9505263158 \text{ atm})(3.978 \text{ L})}{(0.08206 \text{ L-atm/K-mol})(300.15 \text{ K})} = 0.153517915 \text{ mol H}_2
\]

Answer: $0.1535 \text{ mol H}_2$

5. If 0.598 mol N$_2$, 0.153 mol O$_2$, and 0.079 mol CO$_2$ are exhaled into a balloon, what volume would the balloon occupy at STP?

\[
\frac{0.598 \text{ mol N}_2}{0.830 \text{ mol total}} + \frac{0.153 \text{ mol O}_2}{0.830 \text{ mol total}} + \frac{0.079 \text{ mol CO}_2}{0.830 \text{ mol total}} \quad @ \text{STP}
\]

\[
0.830 \text{ mol} \left( \frac{22.4 \text{ L}}{1 \text{ mol}} \right) = 18.592 \text{ L}
\]

Answer: $18.6 \text{ L}$

6. 32.42 mol Gas A, 28.15 mol Gas B, and 19.69 mol Gas C are in a 1799 L chamber at STP. What is the partial pressure of Gas B (in atm)?

\[
PV = nRT
\]

\[
P_B = \frac{n_BRT}{V} = \frac{(28.15 \text{ mol B})(0.08206 \text{ L-atm/K-mol})(273.15 \text{ K})}{(1799 \text{ L})} = 0.3507356839 \text{ atm B}
\]

Answer: $0.3507 \text{ atm B}$