Worksheet 1B

1) How many moles of gas occupy 98 L at a pressure of 2.8 atmospheres and a temperature of 292 K?

\[ n = \frac{PV}{RT} = \frac{(2.8 \text{ atm})(98 \text{ L})}{(0.0821 \text{ L.atm/mol.K})(292 \text{ K})} = 11 \text{ moles of gas} \]

2) If 5.0 moles of O\(_2\) and 3.0 moles of N\(_2\) are placed in a 30.0 L tank at a temperature of 250 °C, what will the pressure of the resulting mixture of gases be?

\[ \begin{align*}
\text{O}_2: P &= \frac{nRT}{V} = \frac{(5.0 \text{ mol})(0.0821 \text{ L.atm/mol.K})(298 \text{ K})}{(30.0 \text{ L})} = 4.1 \text{ atm} \\
\text{N}_2: P &= \frac{nRT}{V} = \frac{(3.0 \text{ mol})(0.0821 \text{ L.atm/mol.K})(298 \text{ K})}{(30.0 \text{ L})} = 2.4 \text{ atm} \\
P_{\text{Tot}} &= P_{\text{O}_2} + P_{\text{N}_2} = 4.1 \text{ atm} + 2.4 \text{ atm} = 6.5 \text{ atm}
\end{align*} \]

3) A 35 L tank of oxygen is at 315 K with an internal pressure of 190 atmospheres. How many moles of gas does the tank contain?

\[ n = \frac{PV}{RT} = \frac{(190 \text{ atm})(35 \text{ L})}{(0.0821 \text{ L.atm/mol.K})(315 \text{ K})} = 260 \text{ moles of gas} \]

4) A balloon that can hold 85 L of air is inflated with 3.5 moles of gas at a pressure of 1.0 atmosphere. What is the temperature in 0 °C of the balloon?

\[ T = \frac{PV}{nR} = \frac{(1 \text{ atm})(85 \text{ L})}{(3.5 \text{ mol})(0.0821 \text{ L.atm/mol.K})} = 296 \text{ K} – 273 \text{ K} = 23.0 \text{ °C} \]

5) A helium balloon with an internal pressure of 1.00 atm and a volume of 4.50 L at 20.00 °C is released. What volume will the balloon occupy at an altitude where the pressure is 0.600 atm and the temperature is –20.00 °C?

\[ \begin{align*}
P_1 &= 1.00 \text{ atm, } V_1 = 4.50 \text{ L, } T_1 = 20.00 \text{ °C} = 293 \text{ K,} \\
P_2 &= 0.600 \text{ atm, } V_2 = \text{? } T_2 = -20.00 \text{ °C} = 253 \text{ K} \\
V_2 &= \frac{P_1 V_1 T}{T_1 P_2} = \frac{(1.00 \text{ atm})(4.50 \text{ L})(253 \text{ K})}{(293 \text{ K})(0.600 \text{ atm})} = 6.48 \text{ L}
\end{align*} \]
6) A gas canister can tolerate internal pressures up to 210 atmospheres. If a 2.0 L canister holding 3.5 moles of gas is heated to 13500 °C, will the canister explode? Should have been 1350 °C, but this works.

\[
P = \frac{nRT}{V} = \frac{(3.5 \text{ mol})(0.0821 \text{ L.atm/mol.K})(13773 \text{ K})}{(2.0 \text{ L})} = 565 \text{ atm}
\]

Yes, the canister will explode.

7) Two flasks are connected with a stopcock. Flask #1 has a volume of 2.5 L and contains oxygen gas at a pressure of 0.70 atm. Flask #2 has a volume of 3.8 L and contains hydrogen gas at a pressure of 1.25 atm. When the stopcock between the two flasks is opened and the gases are allowed to mix, what will the resulting pressure of the gas mixture be?

Flask #1  \( P_1 = 0.70 \text{ atm}, \ V_1 = 2.5 \text{ L O}_2 \)  
Flask #2  \( P_1 = 1.25 \text{ atm}, \ V_1 = 3.8 \text{ L H}_2 \)

After joining flasks \( V_{\text{total}} = 2.5 \text{ L} + 3.8 \text{ L} = 6.3 \text{ L} \)

\[
\frac{P_1 V_1}{n_1 T_1} = \frac{P_2 V_2}{n_2 T_2}
\]

We know the number of moles and the temperature do not change

which leaves  \( P_1 V_1 = P_2 V_2 \) for both the \( \text{O}_2 \) and the \( \text{H}_2; \ V_2 \) is \( V_{\text{total}} \)

\[
P_{\text{O}_2} = \frac{P_1 V_1}{V_{\text{total}}} = \frac{(0.70 \text{ atm}) (2.5 \text{ L})}{(6.3 \text{ L})} = 0.278 \text{ atm}
\]

\( V \) increased so \( P \) decreases

\[
P_{\text{H}_2} = \frac{P_1 V_1}{V_{\text{total}}} = \frac{(1.25 \text{ atm}) (3.8 \text{ L})}{(6.3 \text{ L})} = 0.754 \text{ atm}
\]

\( V \) increased so \( P \) decreases

Dalton gives  \( P_{\text{O}_2} + P_{\text{H}_2} = 0.278 \text{ atm} + 0.754 \text{ atm} = 1.03 \text{ atm} \)