Chapter 5 – Problems 12

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1. Calculate the density of water at STP.

$$\begin{aligned} \text{At STP: } n = 1[\text{mol}],\ V &= 22.4[\text{L}] \\ \rho &= \frac{18 \cdot 1}{22.4} \\ &= .804\left[\frac{\text{g}}{\text{L}}\right] \end{aligned} \tag{1}$$

2. What volume of oxygen at $50[^\circ\text{C}]$ and $1[\text{ATM}]$ is required to combust with $2[\text{g}]$ of C_8H_{18}?

$$\begin{aligned} C_8H_{18} + O_2 &\longrightarrow CO_2 + H_2O \\ 2\,C_8H_{18} + 25\,O_2 &\longrightarrow 16\,CO_2 + 18\,H_2O \\ C_8H_{18} &\longrightarrow 114\left[\frac{\text{g}}{\text{mol}}\right] \\ \frac{2}{114} &= .0175[\text{mol}] \\ .0175 \cdot \frac{25}{2} &= .219[\text{mol}] \\ V &= \frac{nRT}{P} \\ \frac{.219 \cdot .0821 \cdot 323}{1} &= 5.808[\text{L}] \end{aligned} \tag{2}$$

3. Explain in terms of Kinetic Molecular Theory what happens to a container with gas in it when the volume is increased.

   When the volume is increased, the pressure decreases because the molecules make contact with the walls less often.

4. What volume of oxygen is collected with water vapor at 23[°C] by reacting 2.3[g] of $KClO_3$ if the total pressure is 742[MMHG] and water vapor pressure is 21.07[MMHG]?

$$2\,\mathrm{KClO_3} \longrightarrow 2\,\mathrm{KCl} + 3\,\mathrm{O_2} \tag{3}$$

$$\begin{aligned}
742[\textsc{mmHg}] &= .976[\textsc{atm}] \\
21.07[\textsc{mmHg}] &= .0277[\textsc{atm}] \\
m_{\mathrm{KClO_3}} &= 123\left[\frac{\mathrm{g}}{\mathrm{mol}}\right] \\
\frac{2.3}{123} &= .0187[\mathrm{mol}] \\
\frac{3}{2}\cdot .0187 &= .028[\mathrm{mol_{O_2}}] \\
V &= \frac{nRT}{P} \\
\frac{.028\cdot .0821\cdot 296}{.976-.0277} &= .718[\mathrm{L}]
\end{aligned} \tag{4}$$

5. A refrigerant system uses 5.0[in^3] of He compressed to 195[psi] at 20[°C]. What mass of He, in grams, is needed for such a system? (1[in] = 2.54[cm])

$$\begin{aligned}
195[psi] &= 13.27[\textsc{atm}] \\
5[in^3] &= .082[\mathrm{L}] \\
n &= \frac{13.27\cdot .082}{.0821\cdot 293} \\
&= .045[\mathrm{mol}] \\
4\cdot .045 &= .18[\mathrm{g}]
\end{aligned} \tag{5}$$

6. A balloon is filled with 1[L] of helium at 1[ATM] and a starting temperature. The balloon rises to a point where the pressure is 220[TORR], temperature is −31[°C], and the volume of the balloon increases 2.8[L]. What is the starting temperature of the balloon?

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\begin{aligned}
T &= \frac{PV}{nR} \\
\frac{1 \cdot 1}{.0821} &= \frac{12.18}{n}[^\circ\mathrm{K}] \\
n &= \frac{PV}{RT} \\
220[\textsc{torr}] &= .289[\textsc{atm}] \\
\frac{2.8 \cdot .289}{.0821 \cdot 242} &= .0407[\mathrm{mol}] \\
\frac{12.18}{.0407} &= 299.26[^\circ\mathrm{K}]
\end{aligned} \tag{6}
$$

7. If 7.75[g] of SO_2 is added, at constant temp and volume, to 5.87[L] of SO_2 at 705[mmHg] and 26.5[°C], what will be the new gas pressure?

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\begin{aligned}
705[\textsc{mmHg}] &= .928[\textsc{atm}] \\
\mathrm{SO_2} &\longrightarrow 64\left[\frac{\mathrm{g}}{\mathrm{mol}}\right] \\
\frac{7.75}{64} &= .121[\mathrm{mol}] \\
n &= \frac{5.87 \cdot .928}{.0821 \cdot 299.5} \\
&= .222[\mathrm{mol}] \\
P &= \frac{(.222 + .121) \cdot .0821 \cdot 299.5}{5.87} \\
&= 1.44[\textsc{atm}]
\end{aligned} \tag{7}
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