Chapter 5 – Problem Set 1

Michael Brodskiy
Instructor: Mr. Morgan

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1. How many grams of hydrogen is needed to fill a 80[L] tank to a pressure of 150[ATM] at 27[°C]? (1)

$$\begin{aligned} n &= \frac{PV}{RT} \\ \frac{150 \cdot 80}{.0821 \cdot 300} &= 487.211[\text{mol}] \\ 2 \cdot 487 &= 974[\text{g}_\text{H}] \end{aligned} \tag{1}$$

2. At what temperature does 16.3[g] of nitrogen have a pressure of 725[TORR] in a 25[L] tank? (2)

$$\begin{aligned} 725[\text{TORR}] &= .954[\text{ATM}] \\ \frac{16.3}{28} &= .582[\text{mol}_\text{N}] \\ T &= \frac{25 \cdot .954}{.582 \cdot .0821} \\ &= 499[^\circ\text{K}] \end{aligned} \tag{2}$$

3. What is the volume, in [mL], of 837[mg] of xenon gas at STP? (3)

$$\begin{aligned} 837[\text{mg}] &= .837[\text{g}] \\ V_\text{mL} &= 1000 \cdot \frac{.00639 \cdot .0821 \cdot 273}{1} \\ &= 143.4 \cdot [\text{mL}] \end{aligned} \tag{3}$$

4. A gas at STP is in a 25[L] container. The volume is increased to 50[L] and pressure is increased to 1.5[ATM]. What is new temperature? (4)

$$\begin{aligned} P \to 1.5P, V \to 2V \\ 2V \cdot 1.5P &= 3T \\ 3 \cdot 273 &= 819[^\circ\text{K}] \end{aligned} \tag{4}$$

5. A balloon is filled with 1.0[L] of helium at 1.0[ATM] and a starting temp. The balloon rises to a point where the pressure is 220[TORR], temp is $-31[^\circ\text{C}]$, and the volume increases to 2.8[L]. What is the starting temp of the balloon? (5)

$$\begin{aligned} T_1 &= T_2 \frac{P_1 V_1}{P_2 V_2} \\ &= 242 \cdot \frac{1}{.289 \cdot 2.8} \\ &= 299[^\circ\text{K}] \end{aligned} \tag{5}$$

6. How many grams of gas must be released from a 45.2[L] sample of nitrogen at STP to reduce the volume to 45[L] at STP? (6)

$$\begin{aligned} n_1 &= \frac{45.2}{.0821 \cdot 273} \\ n_2 &= \frac{45}{.0821 \cdot 273} \\ n_1 - n_2 &= .0089[\text{mol}] \\ .0089 \cdot 28 &= .25[\text{g}_\text{N}] \end{aligned} \tag{6}$$

7. A neon sign is made of glass tubing whose inside diameter is 2.0[cm] and whose length is 4.0[cm]. If the sign contains neon at a pressure of 1.5[TORR] at 35[°C], how many grams of neon are in the sign? ($V = \pi r^2 h$) (7)

$$\begin{aligned} V &= \pi(1)^2 4 \\ &= 12.57[\text{mL}] \\ &= .01257[\text{L}] \\ 1.5[\text{TORR}] &= .002[\text{ATM}] \\ n &= \frac{.002 \cdot .01257}{.0821 \cdot 308} \\ &= 9.94 \cdot 10^{-7}[\text{mol}] \\ 20 \cdot 9.94 \cdot 10^{-7} &= 1.99 \cdot 10^{-5}[\text{g}] \end{aligned} \tag{7}$$

8. Calculate the number of molecules in a deep breath of air whose volume is 2.55[L] at body temp of 37[°C], and a pressure of 740[TORR]. (**??**)

$$\begin{aligned} n &= \frac{.974 \cdot 2.55}{.0821 \cdot 310} \\ &= .0976[\text{mol}] \\ 6.022 \cdot 10^{23} \cdot .0976 &= 5.88 \cdot 10^{22}[\text{molecules}] \end{aligned} \tag{8}$$