

Solutions, Problem Set #5, CHM 3400  
 Fall 2011, Dr. Chatfield

1. (Atkins 6.5)

$$\Delta_{mix} G_m = RT (x_{O_2} \ln x_{O_2} + x_{N_2} \ln x_{N_2})$$

$$= RT (0.22 \ln 0.22 + 0.78 \ln 0.78)$$

Spontaneous

$$= -1.3 \text{ kJ/mol} \quad \Delta_{mix} S_m = -R (0.22 \ln 0.22 + 0.78 \ln 0.78)$$

$$= 4.38 \text{ J K}^{-1} \text{ mol}^{-1}$$

2. (Atkins 6.9)

Henry's Law:  $P_{HCE} = X_{HCE} K_{HCE}$  ← Henry's Law Constant

This is a linear equation. The question is whether the data satisfy a linear equation & they do,

$K = \frac{P_{HCE}}{X_{HCE}}$  and this ratio is the same for all three data points

$X_{HCE}$	$P_{HCE}$ (kPa)	$\frac{P_{HCE}}{X_{HCE}}$
0.005	32.0	6400
0.022	76.9	6408
0.019	121.8	6412

Very close. Therefore Henry's Law is obeyed very well, and  $K_{HCE} = 6400 \text{ kPa}$

3. (Atkins 6.22)

$$\Delta T = K_f m_B \quad \text{Table 6.3: } K_f(\text{CCl}_4) = 30 \text{ K kg mol}^{-1}$$

$$m_B = \frac{\Delta T}{K_f} = \frac{5.40 \text{ K}}{30 \text{ K kg mol}^{-1}} = 0.18 \text{ mol/kg} = \frac{n_B}{0.750 \text{ kg}}$$

$$n_B = 0.18 \text{ mol kg}^{-1} \cdot 0.750 \text{ kg} = 0.135 \text{ mol}$$

$$\text{molar mass} = \frac{28.09}{0.135 \text{ mol}} = 207.4 \text{ g/mol}$$

4. (Atkins 6.24) Solution below uses a different value for  $\Pi$  than in text (120 instead of 150 kPa).  
With 150 kPa for  $\Pi$ ;  $m_B = 0.0601 \text{ mol/kg}$ ;  $\Delta T = 0.112 \text{ K}$ ;  $T_f = 273.04 \text{ K} = -0.11^\circ \text{C}$

$$0.0831451 \text{ L bar K}^{-1} \text{ mol}^{-1}$$

$$\Pi = [B] RT$$

$\uparrow$  120 kPa                       $\uparrow$  300 K

$$[B] = \frac{\Pi}{RT} = 120 \text{ kPa} \frac{1 \text{ bar}}{100 \text{ kPa}} \frac{1}{0.0831451 \text{ L bar K}^{-1} \text{ mol}^{-1}} \frac{1}{300 \text{ K}}$$

$$= 0.0481 \text{ mol/L}$$

$$m_B \approx [B] \Rightarrow m_B \approx 0.0481 \text{ mol/kg}$$

$$\Delta T = K_f^{(\text{H}_2\text{O})} m_B = 1.86 \text{ K kg mol}^{-1} \cdot 0.0481 \text{ mol kg}^{-1} = 0.0895 \text{ K}$$

$$\uparrow$$

Table 6.3:  $K_f(\text{H}_2\text{O}) = 1.86 \text{ K kg mol}^{-1}$

$$T_f = 273.15 - 0.09 = 273.06 \text{ K} = -0.09^\circ \text{C}$$



6. (Atkins 6.31)

