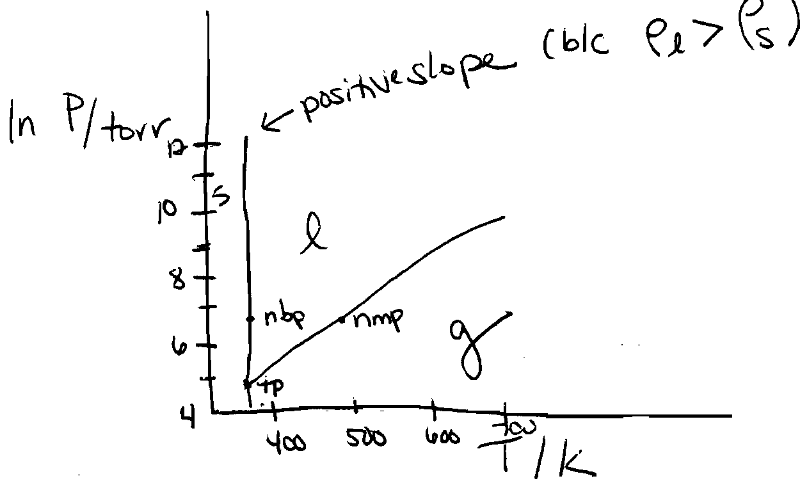
Key for Exam Practice Problems

1.



2. Henry's law: $P_j \rightarrow x_j K_{H,j}$ as $x_j \rightarrow 0$ (dilute sol'n)
Raoult's law: $P_j \rightarrow x_j P_j^*$ as $x_j \rightarrow 1$ (ideal sol'n)

Deviations from Raoult's law are positive. Positive deviations are due to repulsive intermolecular forces between molecules in solution. This causes more molecules to be in gas phase = higher vapor pressure than predicted.

3. P_1^* at 82.0°C ... $\ln P_1^* = 15.8401 - \frac{2790.78}{82 + 226.4}$

$= 6.791$

$P_1^* = 889.7$ torr (82.0°C)

P_1^* at 77.1°C $P_1^* = 768.8$ torr (77.1°C)

P_2^* at 82.0°C $\ln P_2^* = 15.0124 - \frac{2345.4}{82 + 192.7}$ $P_2^* = 648.3$

at 77.1°C $P_2^* = 555.2$ torr @ 77.1°C

$x_1 (82°) = \frac{P_2^* - 760}{P_2^* - P_1^*} = 0.463$ $x_1 (77.1°) = \frac{P_2^* - 760}{P_2^* - P_1^*}$

$x_2 = 1 - 0.463 = 0.537$

4. $a_2 = a_\pm^{\nu} = m_\pm^{\nu} \gamma_\pm^{\nu}$

$CuSO_4$ $\nu_+ = 2$ $\nu_- = -2$ $m_+ = m$ $m_- = m$

$= a_\pm^4 = m^4 \gamma_\pm^4$

or $a_\pm^2 = m^2 \gamma_\pm^2$

5. $CO_{(g)} + 3H_{2(g)} \leftrightarrow CH_{4(g)} + H_2O_{(g)}$

$\Delta G_f^\circ = -137.16 \quad 0 \quad -50.768 \quad -228.58$

$\Delta G_r^\circ = -142.19$ kJ/mol

$K_p = e^{-\Delta G_r^\circ/RT} = 8.38 \times 10^{24} = \frac{P_{CH_4} P_{H_2O}}{P_{CO} P_{H_2}^3}$

The reaction goes nearly to completion.

6. a) The Kp increases w/ increasing T, so rxn is endothermic. $\Delta_r H^\circ$ is positive.

b)

$\ln \frac{K_p(T_2)}{K_p(T_1)} = -\Delta_r H^\circ/R \left(\frac{1}{T_2} - \frac{1}{T_1}\right)$

$R \ln 2 = -\Delta_r H^\circ \left(\frac{1}{400} - \frac{1}{300}\right)$

$\Delta_r H^\circ = 6.91$ kJ/mol

7. $HClO_2 + H_2O \rightarrow ClO_2^- + H_3O^+$

	$HClO_2$	ClO_2^-	H_3O^+
Initial	0.1	0	0
Eq	0.1−x	x	x

$$K_a = \frac{c_{ClO_2^-}\, c_{H_3O^+}\, \gamma_\pm^2}{c_{HClO_2}} = 1.12 \times 10^{-2}$$

1. Assume $\gamma_\pm^2 = 1$

$1.12 \times 10^{-2} = \frac{x^2}{0.1-x} \cdot 1$ $\quad x^2 + 1.12\times10^{-2}x - 1.12\times10^{-3} = 0$

$x = 0.0283\ M$

2. $I_c = \frac{1}{2}\left[(-1)^2 c_{ClO_2^-} + (1)^2 c_{H_3O^+}\right]$

$= 0.0283\ M$

$\ln \gamma_\pm = -\frac{1.173|z_+ z_-| I_c^{1/2}}{1 + I_c^{1/2}} = -0.169$

$\gamma_\pm = 0.845$, $\gamma_\pm^2 = 0.713$

3. $1.12 \times 10^{-2} = \frac{x^2}{0.1-x} \cdot 0.713$ $\quad x^2 + 0.0157x - 0.00157 = 0$

$x = 0.0325\ M$

4. $I_c = 0.0325\ M$

$\gamma_\pm^2 = 0.699$

5. $1.12\times10^{-2} = \frac{x^2}{0.1-x} \cdot 0.699$ $\quad x^2 + 0.0160x - 0.00160 = 0$

$x = 0.0328\ M$

6. $I_c = 0.0328\ M$

$\gamma_\pm^2 = 0.698$

7. $x^2 + 0.0160 - 0.00160 = 0$ $\quad \boxed{x = 0.0328\ M}$ $\quad pH = 1.48$

→ The larger the ka, the stronger the acid.