Key

Practice Quiz – Chapter ~~16~~ 17

1. For each of the following reactions, indicate whether the entropy is expected to increase or decrease. Then explain why.
   a. $CH_3COOH(l) \rightarrow CH_3COOH(g)$ $\boxed{S\downarrow}$ solids are more ordered than liquids
   b. $N_2(g) + O_2(g) \rightarrow NO(g)$ $\boxed{\text{Can't tell}}$ Same # moles, no temp info, same state of matter
   c. $2NH_3(g) + H_2SO_4(aq) \rightarrow (NH_4)_2SO_4(aq)$ $\boxed{S\downarrow}$ (aq) solns are more ordered than gases
   d. $N_2H_4(l) \rightarrow N_2(g) + 2H_2(g)$ $\boxed{S\uparrow}$ Gases are less ordered than liquids

2. a. Determine the ΔG^o value for the following reaction at 25°C. $FeO(s) + H_2(g) \rightarrow Fe(s) + H_2O(g)$

	ΔH^o(kJ/mol)	ΔS^o(J/mol K)
FeO	-272	60.75
Fe(s)	0	27.28
$H_2(g)$	0	130.6
$H_2O(g)$	-241.8	188.7

$\Delta H^\circ = [0 + (-241.8)] - [-272 + 0] = 30.2\ kJ$

$\Delta S^\circ = [27.28 + 188.7] - [60.75 + 130.6] = 24.68\ J/K$

$\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$

$= 30.2\ kJ - 298\ K \cdot 0.02468\ \frac{kJ}{K} = \boxed{22.8\ kJ}$

b. Is this reaction spontaneous or not? Explain. (+) ΔG means not spon.

3. The normal boiling point of sulfuryl chloride, $SO_2Cl_2(l)$ is 69.3°C. Estimate ΔH_{vap} of sulfuryl chloride.

@ B.P., $\Delta G = 0$, so

$\Delta H^\circ_{vap} = T_{BP}\Delta S^\circ_{vap}$

69.3 + 273.2 = 342.5 K

~~$\Delta S^\circ_{vap} = \frac{\Delta H^\circ_{vap}}{T(BP)}$~~ $\Delta H^\circ_{vap} = (342.5\ K)(87\ J/K) = 29{,}800\ J$

$\boxed{\Delta H^\circ_{vap} = 29.8\ kJ}$

4. The following data are given for the sublimation of naphthalene at 298K: $\Delta S^o = 168.7$ J/mol K and $\Delta H^o = 73.6$ kJ/mol. Calculate the pressure of naphthalene vapor in equilibrium with solid naphthalene at 298K. $C_{10}H_8(s) \leftrightarrow C_{10}H_8(g)$

$K_{eq} = K_p = P_{C_{10}H_8}$

$\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ$

$\Delta G^\circ = 73.6\ \text{kJ/mol} - (298\ \text{K})(0.1687\ \text{kJ/K mol})$

$\Delta G^\circ = 23.3\ \text{kJ/mol}$

$\Delta G^\circ = -RT \ln K_{eq}$

$\frac{\Delta G^\circ}{-RT} = \ln K_{eq}$

$\frac{(23.3\ \text{kJ/mol})}{-(.0083145\ \frac{\text{kJ}}{\text{mol}\cdot\text{K}})(298\text{K})} = -9.40 = \ln K_{eq}$

$K_{eq} = e^{-9.40} = \boxed{8.2 \times 10^{-5}\ \text{atm} = P_{C_{10}H_8}}$

5. Calculate ΔG for the reaction $2H_2S(g) + SO_2(g) \leftrightarrow 3S(s) + 2H_2O(g)$, under these conditions:

	Pressure (atm)	ΔG^o_f (kJ/mol)
$H_2S(g)$	1.0×10^{-4}	-34
$SO_2(g)$	1.0×10^{-2}	-300
$H_2O(g)$	3.0×10^{-2}	-229

$\Delta G^\circ = [3(0.1) + 2(-229)] - [2(-34) + 1(-300)]$

$= (.3 - 458) - (-68 - 300)$

$= -457.7 + 368$

$\Delta G^\circ = -89.7\ \text{kJ/mol}$

$\Delta G = \Delta G^\circ + RT \ln Q$

$= -89.7\ \text{kJ/mol} + (.0083145\ \frac{\text{kJ}}{\text{K}\cdot\text{mol}})(298\text{K}) \ln \frac{(3.0\times10^{-2})^2}{(1.0\times10^{-4})^2(1.0\times10^{-2})}$

$\boxed{\Delta G = -50.02\ \text{kJ/mol}}$