SOLUTION HOME WORK CH # 16

5/6

Q.20/20: Entropy increase from solid → liquid → Gas,
Mixing → increase entropy.
a, b, d and f → ΔS (+ve)
c, e → ΔS (-ve)

24/22. a) $\Delta S_{surr} = -\frac{\Delta H}{T} = \frac{-(-2221\,kJ)}{298\,K} = 7.45 \times 10^3\,J/K$

b) $\Delta S_{surr} = -\frac{\Delta H}{T} = \frac{-112\,kJ}{298\,K} = -0.376\,kJ/K = -376\,J/K$

26/34. a) $H_2(g) + \frac{1}{2}O_2(g) \rightarrow H_2O(l)$ $\Delta n = (-ve)$, $\Delta S^\circ = (-ve)$

$\Delta S^\circ = 1\,mol\,H_2O(l)\,(70\,J/k\cdot mol) - [1\,mol\,H_2(g)\,(131\,J/k\cdot mol) + \frac{1}{2}\,mol\,O_2(g)\,(205\,J/k\cdot mol)]$

$= 70.\,J/k - 234\,J/k = -164\,J/k$

b) $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$; $\Delta n = -ve$, $\Delta S^\circ = (-ve)$

$\Delta S^\circ = 2(193) - [1(192) + 3(131)] = -199\,J/k$

c) $HCl(g) \rightarrow H^+_{(aq)} + Cl^\ominus_{(aq)}$; gaseous state (disorder) dominate than ions in solution, $\Delta S^\circ = (-ve)$.

$\Delta S^\circ = 1\,mol\,H^+(0) + 1\,mol\,Cl^-(57\,J/k\cdot mol) - 1\,mol\,HCl(187\,J/k\,mol)$

$\boxed{\Delta S^\circ = -130.\,J/K}$

34/36. $\Delta S^\circ = S^\circ_P - S^\circ_R$ $\quad 2Al(s) + 3Br_2(l) \rightarrow 2AlBr_3(s)$ $\quad \Delta S^\circ = -144\,J/k$

$-144\,J/k = 2\,mol\,S^\circ_{AlBr_3} - [2(28\,J/k) + 3(152\,J/k)]$, $S^\circ_{AlBr_3} = 184\,J/k\cdot mol$

40/46 $\Delta G^\circ = ?$ for $6C(s) + 3H_2(g) \rightarrow C_6H_6(l)$

$6CO_2(g) + 3H_2O(l) \rightarrow C_6H_5(l) + 15/2\,O_2(g)$ $\quad \Delta G^\circ = -\left(\frac{-6399}{2}\right)kJ = +3199\,kJ$

$6C(s) + 6O_2(g) \rightarrow 6CO_2(g)$ $\quad \Delta G^\circ = 6(-394)\,kJ = -2464$

$3H_2(g) + 3/2\,O_2(g) \rightarrow 3H_2O(l)$ $\quad \Delta G^\circ = 3(-237)\,kJ = -811\,kJ$

$6C(s) + 3H_2(g) \rightarrow C_6H_6(l)$ $\quad \Delta G^\circ = 125\,kJ$.

$\Delta G^\circ = ?$

Q 50/52 $2H_2S(g) + SO_2(g) \rightleftharpoons 3S_{rhombic(s)} + 2H_2O(g)$

$\Delta G^\circ = 3(0) + 2(-229) - [2(-34) + 1(-300.)] = -90.\ kJ$

$$\Delta G = \Delta G^\circ + RT \ln \frac{P_{H_2O}^2}{P_{H_2S}^2 \times P_{SO_2}^2} = -90.\ kJ + \frac{(8.3145)(298)}{1000}\ kJ$$

$$\left[\ln \frac{(0.030)^2}{(1.0\times10^{-4})^2(0.010)}\right]$$

$\Delta G = -90.\ kJ + 39.7\ kJ = \underline{-50.\ kJ}$

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Q 66 $\Delta G = \Delta H - T\Delta S$

At boiling point $\Delta G = 0$ so $\Delta S = \frac{\Delta H_{vap}}{T}$

For Methane: $\Delta S = \frac{8.20\times10^3\ kJ/mol}{112\ K} = 73.2\ J/mol.K$

For Hexane: $\Delta S = \frac{28.9\times10^3\ J/mol}{342\ K} = 84.5\ J/mol.K$

$$V_{methane} = \frac{nRT}{P} = \frac{1.00\ mol\ (0.08206)(112\ K)}{1.00\ atm} = \boxed{9.19\ L}$$

$$V_{Hexane} = \frac{nRT}{P} = \frac{1.00\ mol\ (0.08206)(342\ K)}{1.00} = \boxed{28.1\ L}$$

Volume increase → Entropy increase
$V > 0$ $\Delta S > 0$ (+ve)

Volume decrease → Entropy decrease
$V < 0$ $\Delta S < 0$ (−ve)