19.16b

$Ba(OH)_{2(s)} \rightarrow BaO_{(s)} + H_2O_{(g)}$

s → s + g

P 1/2 → 1/4

$\Delta S_{rxn} = n\Sigma S_{prod} - n\Sigma S_{react.}$

$= [\Delta S\, BaO_{(s)} + \Delta S\, H_2O_{(g)}] - [\Delta S\, Ba(OH)_2]$

s → l → g ⊕ ΔS

19.1c 3 moles g → l

g 3 moles g → 2 mole (g)

More gas → less gas

⊖ ΔS

19.58 g $H_{2(g)} + Cl_{2(g)} \rightarrow 2HCl_{(g)}$

Find $\Delta G_{rxn} = n\Sigma prod - n\Sigma react$

$\Delta G_{rxn} = [2\Delta G(HCl_{(g)})] - [\Delta G(H_{2(g)}) + \Delta G(Cl_{2(g)})]$

$= [2(-95.27)] - [0 + 0]$

$\Delta G = -190.54$ kJ

S_{rxn}

$H_2 + Cl_2 \rightarrow 2HCl$

$\Delta H = [2(-92.3)] - [0 + 0]$

$\Delta H = -184.6$ kJ ✓

$H_2 + Cl_2 \rightarrow 2HCl$

$\Delta S = [2(186.69)] - [130.58_{H_2} + 222.96_{Cl_2}]$

$\Delta S = 19.84$ J

$\Delta S = 0.01984$ kJ ✓

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

$\Delta G = -184.6 - 298(0.01984)$

$= -184.6$ kJ

19.76 $6H_{2(g)} + P_{4(g)} \rightarrow 4PH_{3(g)}$

(a) $\Delta G = n\Sigma prod - n\Sigma react$

$= [4\,\Delta G(PH_3)_{(g)}] - [6(\Delta G(H_2)_{(g)} + \Delta G(P_4)]$

$= [4(13.4)] - \{6(0) + 24.4\}$

$\Delta G^\circ = 29.2\ kJ$

$6H_2 + P_4 \rightarrow 4PH_3$

8 atm, 0.05 atm, 0.22

$\Delta G^\circ = +29.2\ kJ$

Non-Spont

Find ΔG

$Q = \frac{(PH_3)^4}{(H_2)^6(P_4)}$

kJ

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

$= 29.2 + \left[(8.314 \times 10^{-3})(298)\left\{\ln \frac{(0.22)^4}{(8)^6(0.05)}\right\}\right]$

$\ln(1.79 \times 10^{-7}) = (-15.54)$

$= 29.2 + -38.5$

$\Delta G = -9.5\ kJ$

19.79 $BaCO_{3(s)} \overset{\text{AT EQ}}{\rightleftharpoons} BaO_{(s)} + CO_{2(g)}$

(solid) (solid) (gas)

Table ② Calculate Pressure of $CO_{2(g)}$ at 298 K

$\Delta G^\circ = -RT\ln K$

$218.1 = -(8.314\times10^{-3})(298)\ln K$

$\ln K = -88.03$

$K = 5.88\times10^{-39}$

$P_{CO_2} = 5.88\times10^{-39}$ atm

$K = P_{CO_2}(1)$ (1)

ⓒ $\Delta G^\circ = [-525.1 + -394.4]_{BaO,\ CO_2} - [-1137.6]_{BaCO_3}$

$\Delta G^\circ = +218.1$ kJ

19.81 ⓐ $HNO_2 \rightarrow H^+ + NO_2^-$

ⓑ $K_a = 4.5\times10^{-4}$

ⓐ $K = \frac{[H^+][NO_2^-]}{[HNO_2]} = Q$

ⓑ Find ΔG° $\Delta G^\circ = -RT\ln K$

ⓒ $\Delta G^\circ = (-8.314\times10^{-3})(298)\ln 4.5\times10^{-4}$

$\Delta G^\circ = 19.09$ kJ

ⓓ $\Delta G = 0$ AT EQ

ⓔ Find ΔG when $[H^+] = 5\times10^{-2}$ M, $[NO_2^-] = 6\times10^{-4}$ M, $[HNO_3] = 0.2$ M

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

$\Delta G = 19.09 + (8.314\times10^{-3})(298)\ln\frac{(5\times10^{-2})(6\times10^{-4})}{0.2}$ (H^+)(NO_2^-) / (HNO_2)

$\Delta G = -2.72$ kJ

HW PS 19.1 skip #8 + 22

PS 19 (23)

$2Hg(\ell) + O_{2(g)} \rightleftharpoons 2HgO_{(s)}$

(liquid) (gas) (solid)

$K = \frac{1}{1[O_2]}$

200° C → 473 K

$\Delta G^\circ = -RT \ln K$

$= (8.314 \text{ kJ})(473) \ln K$

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