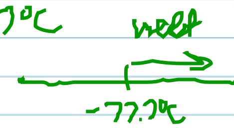
3/24/11

18.42 $NH_{3(s)} \longrightarrow NH_{3(l)}$ mp = −77.7°C



	ΔH	ΔS	ΔG
−60°C	+	+	−
−77.7°C	+	+	0
−100°C	+	+	+

18.48 $2\overset{+2-2}{CO} + 2\overset{+2-2}{NO} \longrightarrow 2\overset{+4-2}{CO_2} + \overset{0}{N_2}$

C: +2 → +4   CO = red. agent
N: +2 → ∅   NO = ox. agent

c) Kp @ 25°C $\Delta G° = -RT\ln K_p$

$\Delta G° = \sum \Delta G_f°$ products $- \sum \Delta G_f°$ reactants

$\Delta G° = -687.6$ kJ

$$\ln K_p = \frac{\Delta G°}{-R\,T} = \frac{-687.6 \times 10^3 J}{-(8.314 J/mol \cdot K)(298K)} = 278$$

$e^{278} = K_p = 1 \times 10^{121}$

d) $$Q_p = \frac{P_{CO_2}^2 \cdot P_{N_2}}{P_{CO}^2 \cdot P_{NO}^2} = 1.2 \times 10^{18}$$

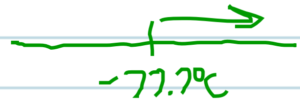
$Q_p < K_p$ reaction proceeds forwards, to right, towards products

e) ΔG (−)
ΔS (−)
ΔH (−)

↑T ⇒ ΔG becomes less negative

3/24/11

18.42 $NH_{3(s)} \longrightarrow NH_{3(g)}$ mp = −77.7°C melt



	ΔH	ΔS	ΔG
−60°C	+	+	−
−77.7°C	+	+	0
−100°C	+	+	+

18.48 $\overset{+2\,-2}{2\,CO} + \overset{+2\,-2}{2\,NO} \longrightarrow \overset{+4\,-2}{2\,CO_2} + \overset{0}{N_2}$

C: +2 → +4 CO = red. agent

N: +2 → ∅ NO = ox. agent

c) Kp @ 25°C $\Delta G^\circ = -RT \ln K_p$

$\Delta G^\circ = \sum \Delta G_f^\circ \text{ products} - \sum \Delta G_f^\circ \text{ reactants}$

$\Delta G^\circ = -687.6 \text{ kJ}$

$$\ln K_p = \frac{\Delta G^\circ}{-RT} = \frac{-687.6 \times 10^3 \text{ J}}{-(8.314 \text{ J/mol·K})(298 \text{ K})} = 278$$

$e^{278} = K_p = 1 \times 10^{121}$

d) $$Q_p = \frac{P_{CO_2}^2 \cdot P_{N_2}}{P_{CO}^2 \cdot P_{NO}^2} = 1.2 \times 10^{18}$$

$Q_p < K_p$ reaction proceeds forwards, to right, towards products

e) ΔG (−)
ΔS (−)
ΔH (−)

↑T ⇒ ΔG becomes less negative

(18.59) $Hg_{(l)} \rightleftharpoons Hg_{(g)}$

Hess' Law P - R

ΔH°

ΔS°

assumption

@ $\Delta G = 0$

$T = \frac{\Delta H}{\Delta S} = 625K$

ΔH, ΔS are not significantly different than standard ΔH°, ΔS°

(18.74) $\overset{+1\ -2}{2H_2S_{(g)}} + \overset{+4\ -2}{SO_{2(g)}} \rightleftharpoons \overset{0}{3S_{(s)}} + \overset{+1\ -2}{2H_2O_{(g)}}$

a) reverse disproportionation

b) $\ln K_p = \frac{\Delta G^\circ}{-RT}$ ← Hess' Law

$K_p = 7.9 \times 10^{15}$

c) ΔG (-)

ΔS (-) ↑T less products

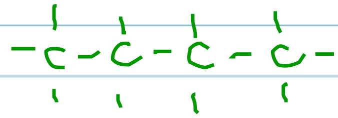
ΔH (-) ΔG is less negative

(18.76) $2O_3 \rightleftharpoons 3O_{2(g)}$ (-30°C)

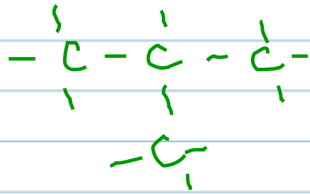
$K_p = 1.8 \times 10^{70}$

Ea is large ⇒ rxn is slow

18.82



butane



isobutane

butane $\rightleftharpoons$ isobutane

$\Delta G_f^\circ = -15.9\,kJ$ $\qquad \Delta G_f^\circ = -18.0\,kJ$

$\Delta G^\circ = P - R = -2.1\ kJ/mol$

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

$K_p = 2.3 = \frac{P_{isobutane}}{P_{butane}} \propto \frac{n_{isobutane}}{n_{butane}}$

2.3 mol isobutane for every 1 mol butane

$X_{isobutane} = \frac{2.3\ mol}{3.3\ mol} = 0.70$

70% isobutane