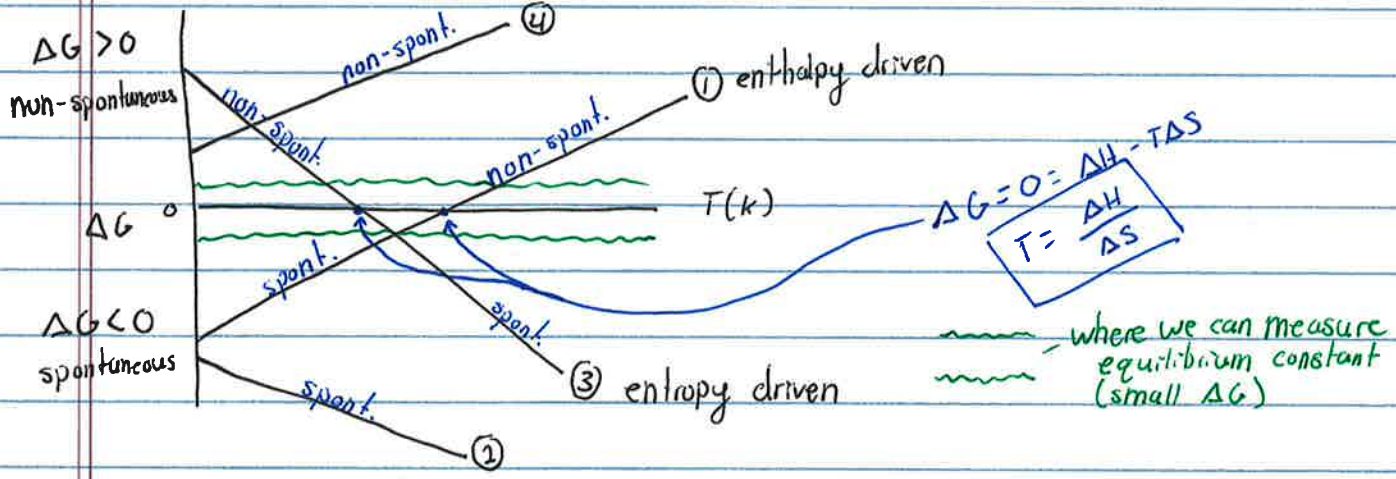
3-27-19

1) $2Mg_{(s)} + O_{2(g)} \rightarrow 2MgO_{(s)}$ $\Delta H = -$, $\Delta S = -$, $\Delta G = \bullet -$

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

$= (-) - (+)(-)$

spontaneous at low temperatures and non-spontaneous at high temperatures



2) Combustion of ethanol, C_2H_5OH $\Delta H < 0$, $\Delta S > 0$, $\Delta G < 0$

$C_2H_5OH_{(g)} + 3O_{2(g)} \rightarrow 2CO_{2(g)} + 3H_2O_{(g)}$

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

$(-) = (-) - (+)(+)$ always spontaneous

3) $N_2O_{4(g)} \rightleftarrows 2NO_{2(g)}$ $\Delta H > 0$, $\Delta S > 0$, $\Delta G = ?$

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

$= (+) - (+)(+)$

non-spontaneous at low temp, spontaneous at high temp

4) $A \rightarrow B$ $\Delta H > 0$, $\Delta S < 0$, $\Delta G > 0$ always non-spontaneous

$2CO_{(g)} \rightarrow O_{2(g)} + 2C_{(s)}$

$HA + OH^- \rightleftharpoons H_2O + A^-$ $K_a = \frac{1}{K_b} = big$

$\Delta G < 0$

$Ca(OH)_2 \rightleftharpoons Ca^{2+} + 2OH^-$ $K_{sp} = small$, $\Delta G > 0$

$$\boxed{\Delta G = \Delta G^\circ + RT \ln Q}$$ Q_p for gases Q_c for solutions

$N_2O_4(g) \rightleftharpoons 2NO_2$ $\Delta G^\circ = 2.8\,kJ$ (slightly non-spontaneous)

ΔG_f $+99.8\,kJ/mol$ $+51.3\,kJ/mol$

$x - 1\,mol$ $x\,2\,mol$

$-99.8\,kJ + 102.6\,kJ = 2.8\,kJ$

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

$= +2.8\,kJ + (8.314 \times 10^{-3}\,kJ/K)(298K)$

$\Delta G = 2.8\,kJ + (8.314 \times 10^{-3}\,kJ/K)(298K)\ln(1 \times 10^{-4})$

$\Delta G = -20.0\,kJ$

P	N_2O_4	$\rightleftharpoons$	$2NO_2$
I	1.0 atm		0.010 atm
C			
E			

$Q_p = \frac{(P_{NO_2})^2}{P_{N_2O_4}}$

$Q_p = 1 \times 10^{-4}$

P	N_2O_4	$\rightleftharpoons$	$2NO_2$
I	0.010 atm		1.0 atm

$Q_p = 100$

$\Delta G = 2.8\,kJ + (8.314\,kJ/K)(298K)\ln(100)$

$\Delta G = 14.2\,kJ$

At equilibrium, $\Delta G = 0$

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

$0 = \Delta G^\circ + RT \ln K$

$$\boxed{\Delta G^\circ = -RT \ln K}$$

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

$$\boxed{\Delta G^\circ = RT\left(\ln\left(\frac{Q}{K}\right)\right)}$$

if $Q > K$ $\frac{Q}{K} > 1$ $\Delta G > 0$ non-spont.

if $Q < K$ $\frac{Q}{K} < 1$ $\Delta G < 0$ spont.