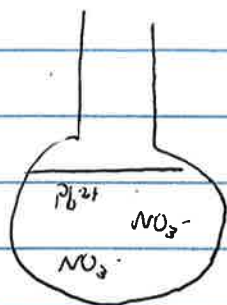
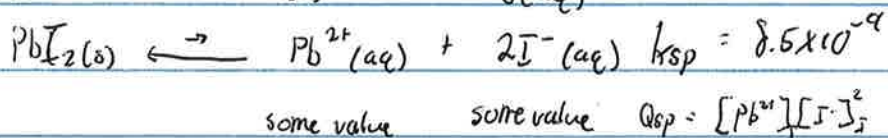


Today: Start ch 17 (first ~8 sections)

Monday: Section 17.9, 17.10

Wednesday: Sections 17.10, 17.11



\* In the vortex initially  $Q_{\text{sp}} > K_{\text{sp}}$ , as time goes by it dissipates into the rest of the solution so  $Q_{\text{sp}} < K_{\text{sp}}$  and it shifts back to the ~~left~~ right

$\Delta H$  "is heat given off?" "Does it take heat?"

↳ yes  $\Delta H < 0$  (exothermic)      ↳ yes  $\Delta H > 0$  (endothermic)

↳ no  $\Delta H > 0$  (endothermic)      ↳ no  $\Delta H < 0$  (exothermic)

$\Delta S$  "is there more disorder?"

↳ yes, entropy favored  $\Delta S > 0$

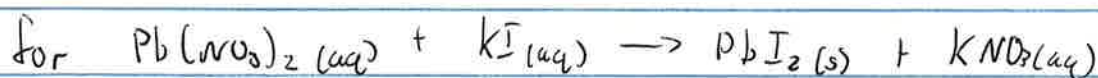
↳ no, entropy not favored  $\Delta S < 0$

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

$\Delta G =$  free energy

$\Delta G < 0$ , spontaneous reaction "Does it happen?"

$\Delta G > 0$ , nonspontaneous



$\Delta S < 0$  (not favored)

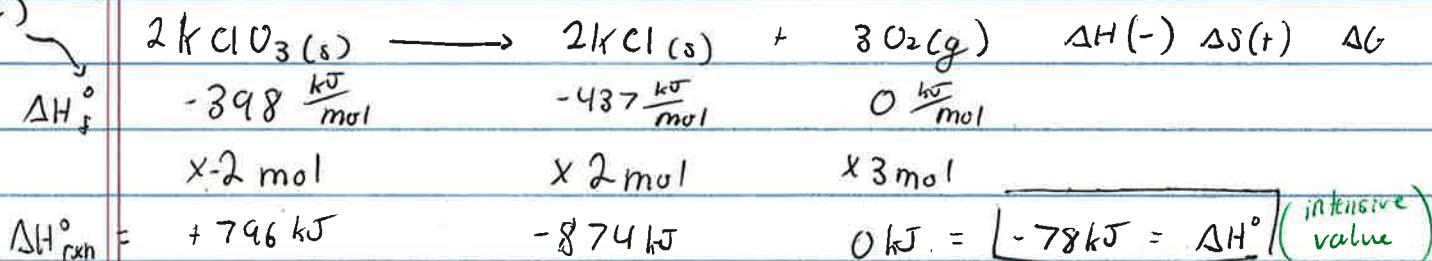
$$\Delta G < 0$$

$$\therefore \Delta H < 0$$

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

	$\Delta H$	$\Delta S$	$\Delta G$
Sugar dissolving in hot water	?	+	-
Mixing exhaust fumes with air	?	+	-
$H_2O(l) \rightarrow H_2O(g)$	+	+	depends on temperature
$H_2O(s) \rightarrow H_2O(l)$	+	+	depends on temperature
$H_2O(l) \rightarrow H_2O(s)$	-	-	depends on temperature
$2N_2O_5(g) \rightarrow 4NO_2(g) + O_2(g)$	?	+	-
$H_3O^+(aq) + OH^-(aq) \rightleftharpoons 2H_2O(l)$	?	?	-
$HC_2H_3O_2 + H_2O \rightleftharpoons H_3O^+ + C_2H_3O_2^-$	?	?	+
$C_2H_3O_2^- + H_3O^+ \rightleftharpoons H_2O + HC_2H_3O_2$	?	?	-

$\Delta$  is standard conditions (1 atm, 25°C)



absolute entropy  $S^\circ$

	$+143 \frac{J}{mol K}$	$+83 \frac{J}{mol K}$	$+205 \frac{J}{mol K}$	
	x-2 mol	x 2 mol	x 3 mol	
$\Delta S_{rxn}^\circ$	$-286 \frac{J}{K}$	$+166 \frac{J}{K}$	$+615 \frac{J}{K}$	$= 495 \frac{J}{K}$

**298k!!!**

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

$$\Delta G^\circ = -78 kJ - (298k)(0.495 \frac{kJ}{K})$$

$$\Delta G^\circ = -225.51 kJ = -226 kJ$$

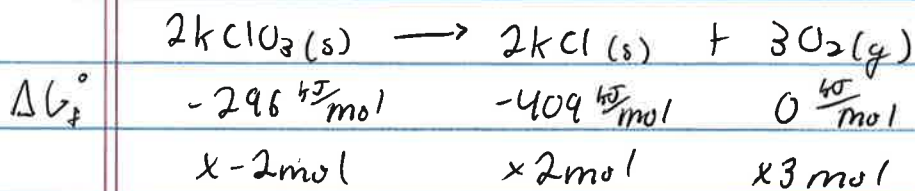
what is  $\Delta G$  at 310k?

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

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

$$\Delta G \approx -78 kJ - (310k)(0.495 \frac{kJ}{K})$$

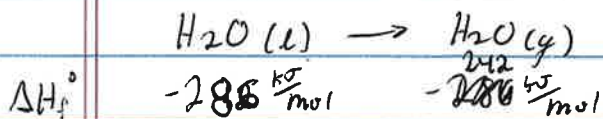
$$\Delta G \approx -231 kJ$$



$$\Delta G_{\text{rxn}}^\circ = 592 \text{ kJ} - 818 \text{ kJ} + 0 \text{ kJ} = \boxed{-226 \text{ kJ} = \Delta G_{\text{rxn}}^\circ}$$

All phase changes have  $\Delta H$  and  $\Delta S$  the same sign.

And  $\Delta G = 0$



$$288 \text{ kJ} - 242 \text{ kJ} = +44 \text{ kJ}$$

$$S^\circ \quad 70 \frac{\text{J}}{\text{mol K}} \quad 189 \frac{\text{J}}{\text{mol K}}$$

$$\times 1 \text{ mol} \quad \times 1 \text{ mol}$$

$$-70 \frac{\text{J}}{\text{K}} + 189 \frac{\text{J}}{\text{K}} = 119 \frac{\text{J}}{\text{K}}$$

to estimate boiling point:

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

$$0 = \Delta H - T\Delta S$$

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

$$T = \frac{+44 \text{ kJ}}{.119 \text{ kJ}} = 370 \text{ K} = 97^\circ \text{C}$$