

General Chemistry II with Dr. Mattson

Today 3/22 Section 17.5 - 17.9

Lab Thursday 3/23 Buffers Recipe 2 or 3
prelab presentation

Friday 3/24 Section 17.10 - 17.11
Relate ΔG to Q and ΔG° to K

Monday 3/27 No class

Wednesday 3/29 Quiz

Find ΔG , ΔH , ΔS

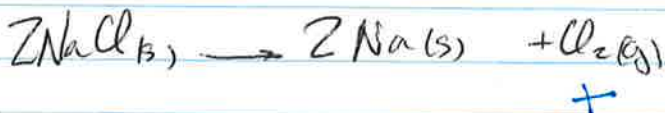
Diffusion of Perfume

Does it happen?
water wheel?
change in order?

ΔG ΔH ΔS

- $\sim 0?$ +
+ +

$\Delta G = \text{above } 100^\circ\text{C}$
 $\Delta S = \text{below } 100^\circ\text{C}$

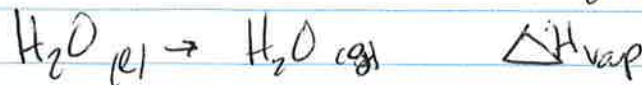


$$\text{H}_2\text{O}(\text{s}) \quad S^\circ = 3.4 \text{ J/molK}$$

$$\text{H}_2\text{O}(\text{l}) \quad S^\circ = 70 \text{ J/molK}$$

$$\text{H}_2\text{O}(\text{g}) \quad S^\circ = 189 \text{ J/molK}$$

Standard conditions
298 K, 1 atm



$$\Delta H_f^{\circ} \begin{array}{r} -285.8 \text{ kJ/mol} \\ \times -1 \text{ mol} \\ \hline 285.8 \text{ kJ} \end{array} \quad \begin{array}{r} -241.8 \text{ kJ/mol} \\ \times 1 \text{ mol} \\ \hline -241.8 \text{ kJ} \end{array}$$

$$285.8 - 241.8 = 44 \text{ kJ} = \Delta H_{\text{vap}}^{\circ}$$

$$S^{\circ} \begin{array}{r} \text{H}_2\text{O}_{(l)} \rightarrow \text{H}_2\text{O}_{(g)} \\ 69.9 \text{ J/molK} \quad 188.7 \text{ J/molK} \\ \times -1 \text{ mol} \quad \times 1 \text{ mol} \\ \hline -69.9 \text{ J/K} \quad +188.7 \text{ J/K} \end{array}$$

$$\Delta S^{\circ} = -69.9 + 188.7 \text{ J/K} = 118.8 \text{ J/K}$$

for $\Delta G^{\circ} = \Delta H^{\circ} - T \Delta S^{\circ}$ \leftarrow at 298 K

$$\Delta G = \Delta H - T \Delta S \rightarrow \text{any temp}$$

if $\Delta G < 0$, spontaneous
 $\Delta G = 0$ changes
 $\Delta G > 0$ non spontaneous

at boiling pt, $\Delta G = 0$

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

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

$$T \Delta S = \Delta H$$

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

* only when $\Delta G = 0$
 $T \approx \frac{\Delta H}{\Delta S} \approx \frac{\Delta H^{\circ}}{\Delta S^{\circ}}$



III never spont

I non spont at low T
spont at high T

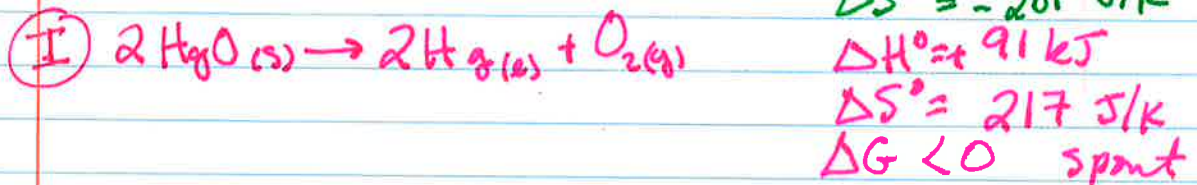
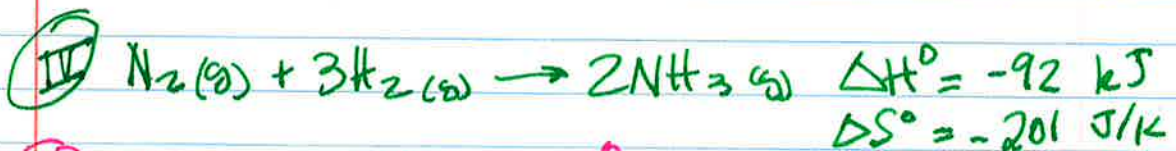
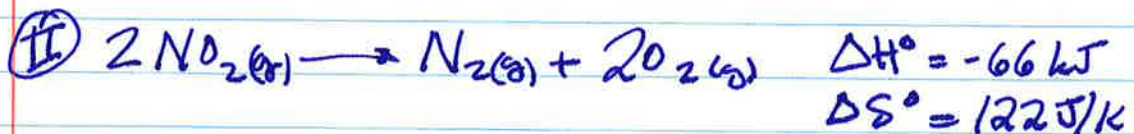
always spontaneous

I $\frac{\Delta H}{+}$ $\frac{\Delta S}{+}$ combus $\Delta G = \Delta H - T\Delta S$
 $= (+) - (+)(+)$
 for water $= 44.0 \text{ kJ} - 298 \times 0.1188 \text{ J/K}$
 $= 8.60 \text{ kJ}$
 change to 303K
 $= 8.00 \text{ kJ}$

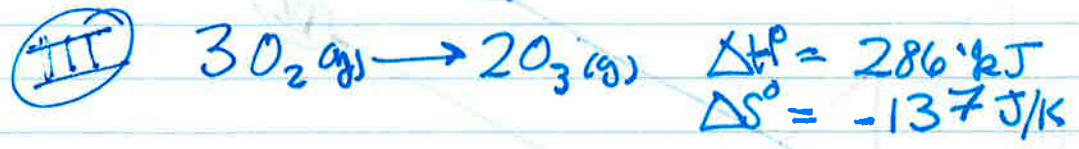
II $-$ $+$ $- = (-) - (+)(+)$

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

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



more than (III)



Tend to decrease
 Tend to increase

$(+)(+) - (+) = +$	+	+	(I)
$(+)(+) - (-) = -$	+	-	(II)
$(-)(+) - (+) = +$	-	+	(III)
$(-)(+) - (-) = -$	-	-	(IV)

- (I) $2NO_2(g) \rightarrow N_2O_4(g)$ $\Delta H^\circ = -58 \text{ kJ}$
 $\Delta S^\circ = -175 \text{ J/K}$
- (II) $2H_2O(l) \rightarrow 2H_2(g) + O_2(g)$ $\Delta H^\circ = +572 \text{ kJ}$
 $\Delta S^\circ = +327 \text{ J/K}$
- (III) $2H_2O(g) \rightarrow 2H_2(g) + O_2(g)$ $\Delta H^\circ = +485 \text{ kJ}$
 $\Delta S^\circ = +327 \text{ J/K}$