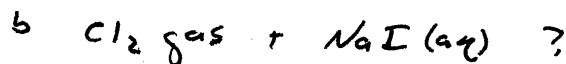


I_2 red + 0.54 V

Cl^- ox - 1.36 V

so E° would be -0.82 V

so no rxn
would occur(if ΔG° would thus be
positive)

that's just the reverse of the one above -

so $E^\circ = +0.82$ V

$\Delta G^\circ = -nFE^\circ$

$= -(2)(96,485 \frac{C}{mol})(0.82 \frac{J}{C})$

$= -158 \text{ kJ/mol}$

$K = e^{-\Delta G^\circ / RT}$

$= e^{-(-158,000 \text{ J/mol}) / (8.314 \text{ J/molK})(298 \text{ K})}$

$= 5.46 \times 10^{27}$

5.5×10^{27}

yes, I've carried along
one more sig fig than
I should have - I hate
cumulative rounding
errors!

$K = 1.28 \times 10^{83}$!

a. $\Delta G^\circ = -RT \ln K$ $T = 298 \text{ K}$

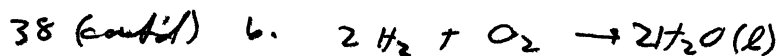
$= -474 \text{ kJ/mol}$

$E^\circ = -\frac{\Delta G^\circ}{nF}$

$= -\frac{(-474,000 \text{ J/mol})}{(4 e^- \text{ transferred})(96,485 \text{ J/V mol})}$

$= 1.23 \text{ V}$ (as expected)

$1 \text{ C} = 1 \text{ J/V}$



ΔH° - exothermic or endothermic?

The crash of the Hindenburg generated a bit of heat, eh? (Do a Google search on "Hindenburg" if you're not familiar with the famous video.) ΔH° is negative.

3 things \rightarrow ΔS° generally has a negative ΔS°
In this case we also have gases \rightarrow liquid,
so ΔS° should be very negative.

c. $\Delta G^\circ = W_{max}$ for the fuel cell rxn.

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

neg ↑ neg ↑ neg

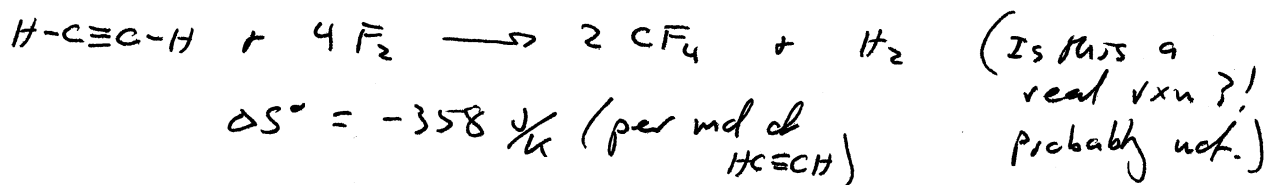
This term makes a positive contribution to ΔG° , the magnitude of which increases with T

so ΔG° & the maximum work that could be produced would decrease as T increases.

39. We did that in class + in lab.

If ΔS° were ≈ 0 , ΔG° , and thus E° would not be strongly temperature-dependent.

41.



$$\Delta S^\circ = -358 \frac{\text{J}}{\text{K mol}} \quad (\text{per mol of HC}\equiv\text{CH})$$

$$= \sum S^\circ(\text{products}) - \sum S^\circ(\text{reactants})$$

$$-358 \frac{\text{J}}{\text{K mol}} = 2 S^\circ(\text{CF}_4) + 131 \frac{\text{J}}{\text{K mol}} - 201 \frac{\text{J}}{\text{K mol}} - 4(203 \frac{\text{J}}{\text{K mol}})$$

$$S^\circ(\text{CF}_4) = 262 \frac{\text{J}}{\text{K mol}}$$

45. H₂

$$\Delta H_{\text{vap}} = 58.51 \frac{\text{kJ}}{\text{mol}}$$

$$\Delta S_{\text{vap}} = 92.92 \frac{\text{J}}{\text{mol K}}$$

$$T_b = \frac{\Delta H_{\text{vap}}}{\Delta S_{\text{vap}}} = \frac{58510 \frac{\text{J}}{\text{mol}}}{92.92 \frac{\text{J}}{\text{mol K}}}$$

$$T_b = 629.7 \text{ K } (= 331.5^\circ \text{C})$$

$$46. \quad \Delta H_{\text{vap}} = 38.7 \frac{\text{kJ}}{\text{mol}} \quad \text{at } T_b = 351 \text{ K}$$

$$\Delta S_{\text{vap}} = \frac{\Delta H_{\text{vap}}}{T} = 110 \frac{\text{J}}{\text{K mol}} \times 1 \text{ mol} = 110 \frac{\text{J}}{\text{K}}$$

this is positive for the "system" - entropy increases upon going from liquid to vapor

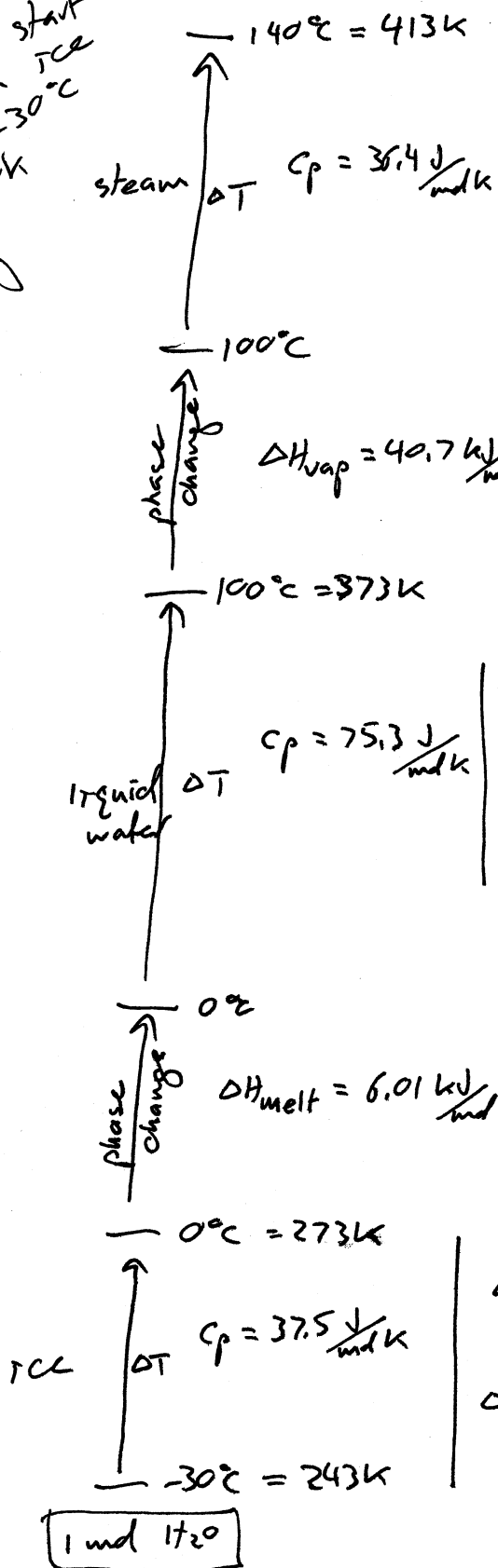
Since vaporization is endothermic, heat flows in from surroundings, so $\Delta S_{\text{sur}} = \frac{-38700 \text{ J}}{351 \text{ K}}$

$$\Delta S_{\text{univ}} = 0 \quad (\text{this is, for all practical purposes, a reversible process}) = -110 \frac{\text{J}}{\text{K}}$$

13. ch 10, 30. 1 mol of ice at -30°C \rightarrow 1 mol of steam at 140°C

$P = 1 \text{ atm.}$

Let's start with ice at -30°C + work our way up



$$\Delta S = n C_p \ln \frac{T_2}{T_1} = 3.71 \text{ J/K}$$

$$q = n C_p \Delta T = 1.456 \text{ kJ}$$

$$\Delta H = q = 1.456 \text{ kJ}$$

$$w = -P \Delta V = -n R \Delta T = -0.332 \text{ kJ}$$

$$\Delta S = \frac{\Delta H_{\text{vap}}}{T} = 109.1 \text{ J/K}$$

$$q = \Delta H = 40.7 \text{ kJ}$$

$$w = -P \Delta V \approx -P V_{\text{gas}} = -n R T = -3.10 \text{ kJ}$$

(ignoring vol of liquid)

$$\Delta S = n C_p \ln \frac{T_2}{T_1} = 23.50 \text{ J/K}$$

$$q = n C_p \Delta T = 7.53 \text{ kJ}$$

$$\Delta H = q = 7.53 \text{ kJ}$$

$$w = 0 \text{ again } (\Delta V \approx 0)$$

$$\Delta S = \frac{\Delta H_{\text{melt}}}{T} = 22.01 \text{ J/K}$$

$$q = \Delta H = 6.01 \text{ kJ}$$

$$w = 0$$

$$\Delta S = n C_p \ln \frac{T_2}{T_1} = 4.365 \text{ J/K}$$

$$q = n C_p \Delta T = 1.13 \text{ kJ}$$

$$\Delta H = q = 1.13 \text{ kJ}$$

$$w = 0 \text{ (no vol. change)}$$

now, adding these up, we have:

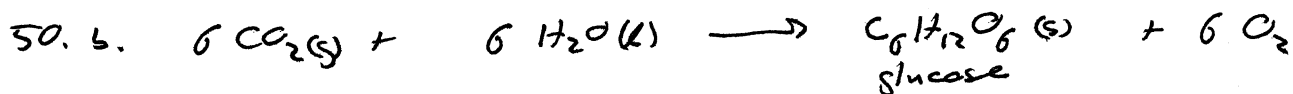
$$\Delta S = 163 \text{ J/K}$$

$$\Delta H = 56.8 \text{ kJ}$$

$$q = 56.8 \text{ kJ}$$

$$w = -3.43 \text{ kJ}$$

↑
negative \Rightarrow system did work on surroundings due to the formation & expansion of the steam



$$n \times \Delta G_f^\circ: \quad 6 \times -394 \quad 6 \times -237 \quad -911 \quad 6 \times 0 \text{ kJ/mol}$$

$$n \times \Delta H_f^\circ: \quad 6 \times -393,5 \quad 6 \times -286 \quad -1275 \quad 6 \times 0 \text{ kJ/mol}$$

$$n \times S^\circ: \quad 6 \times 214 \quad 6 \times 70 \quad 212 \quad 6 \times 205 \text{ J/K}$$

$$\Delta G^\circ = +2875 \text{ kJ/mol} \quad \text{from } \Delta G_f^\circ \text{ s}$$

$$\Delta H^\circ = +2802 \text{ kJ/mol} \quad \text{from } \Delta H_f^\circ \text{ s}$$

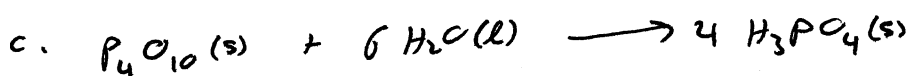
$$\Delta S^\circ = -262 \text{ J/K} \quad \text{from } S^\circ \text{ s}$$

we can also calculate ΔG° from $\Delta H^\circ + \Delta S^\circ$ —

$$\Delta G^\circ = 2802 \text{ kJ/mol} - (298\text{K})(-0,262 \text{ kJ/K})$$

$$= 2880 \text{ kJ/mol} \quad \checkmark$$

that's easier.



as above ...

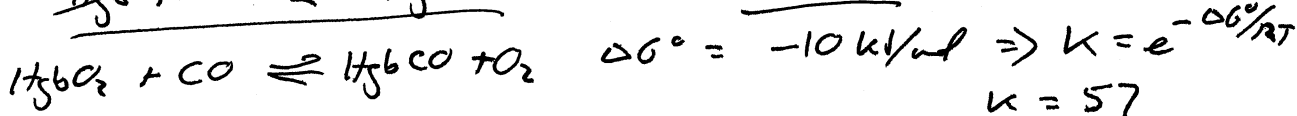
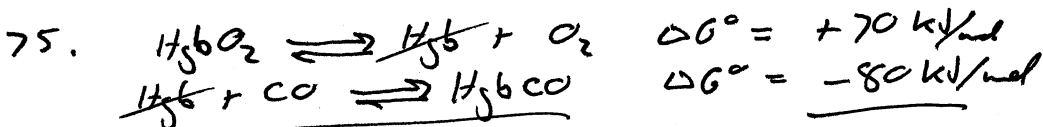
$$\Delta H^\circ = -416 \text{ kJ/mol}$$

$$\Delta S^\circ = -209 \text{ J/K}$$

$$\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ = -354 \text{ kJ/mol}$$

57. see text answer

59. " " "



$$K = 57$$

$$91. \quad K_a = 7,2 \times 10^{-4} \text{ at } 298\text{K} \Rightarrow$$

$$\Delta G^\circ = +18 \text{ kJ/mol}$$

$$\Delta G = \Delta G^\circ + RT \ln \frac{[\text{H}^+][\text{F}^-]}{[\text{HF}]}$$

b. I get $\Delta G = +0,081$ so this is very close to equilibrium.

d. That one is zero... $\Delta G = 0 \Rightarrow$ this is at equilibrium.