

Key to Chem 103 Test #2

Average = 75/150 (50%) highest: 144/150

A ≥ 125 B ≥ 105 C ≥ 70

Part I

1 C	2 E	3 D	4 E	5 D
6 E	7 A	8 D	9 B	10 B

Part II

11.

$$a) \Delta G = -RT \ln K; \Rightarrow K = e^{-\Delta G / RT} = \exp(3.28 \times 10^4 \text{ J mol}^{-1} / (8.3145 \text{ J K}^{-1} \text{ mol}^{-1} \times 298.2 \text{ K})) = 5.56 \times 10^5.$$

$$b) \Delta G = \Delta G^\circ + RT \ln Q \text{ where } Q = (0.22)^2 / (3.5 \times (1.2)^3) = 8.0 \times 10^{-3}.$$

$$\Delta G^\circ = -3.28 \times 10^4 \text{ J mol}^{-1} + (8.314 \text{ J K}^{-1} \text{ mol}^{-1} \times 298.2 \text{ K}) \ln (8.0 \times 10^{-3})$$

$$= (-32.8 - 12.0) \text{ kJ mol}^{-1} = -44.8 \text{ kJ mol}^{-1}.$$

$$12. \Delta H_1 = \Delta H_2 = \Delta H$$

$$\text{at the respective boiling points : } \Delta G_1 = 0 = \Delta H_1 - (164+273)(58.1) = \Delta G_2 = \Delta H_2 - (236+273)(\Delta S_2)$$

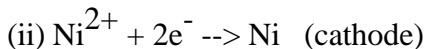
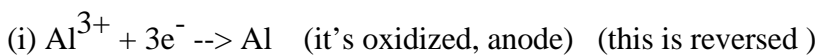
$$\Rightarrow \Delta S_2 = (437 \text{ K})(58.1 \text{ J/K}) / (509 \text{ K}) = 49.9 \text{ J/K}$$

$$13. \Delta H^\circ = 4(-241.84) + 3(-393.52) - (-104.8) = -2043 \text{ kJ/mol}$$

$$\Delta S^\circ = 4(188.74) + 3(213.80) - 270.2 - 5(205.15) = 754.96 + 641.4 - 270.2 - 1027.75 = 100.41$$

$$\Delta G^\circ = \Delta H^\circ - T\Delta S^\circ = (-2043) - (120+273)(100.41) = -2043 - 41.6 = -2083 \text{ kJ/mol}$$

14. write balanced equation:



To get balanced equation: $2x(-\text{i}) + 3x(\text{ii})$:



$$E_{\text{cell}} = E_{\text{cell}}^\circ - 0.0592/6 \log \{ [\text{Al}^{3+}]^2 / [\text{Ni}^{2+}]^3 \} = 1.41 - .0099 \log (.0502 / 2.03)$$

$$= 1.44 \text{ V}$$

15. a) answer = -0.14 V (It's good to draw a diagram)

F_2/F is the highest in the table, so:

F₂/F

1.67V

Pt²⁺/Pt

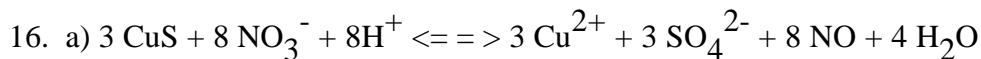
(1.20V)

3.01V

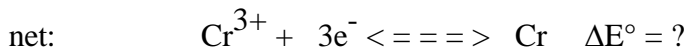
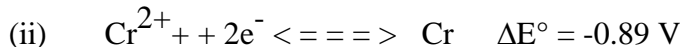
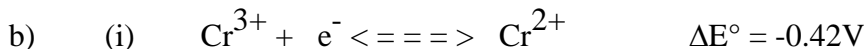
Sn²⁺/Sn

$E_{\text{Pt}^{2+}/\text{Pt}} = 1.20\text{V}$ so $E_{\text{Sn}^{2+}/\text{Sn}} = 1.20 - (3.01 - 1.67) = 1.20 - 1.34 = -0.14\text{V}$

b) And $E_{\text{cell}} = 1.20 - (-0.14) = 1.34\text{V}$



oxidant is NO_3^- (or if you want, N); reductant is CuS (or if you want S^{2-})

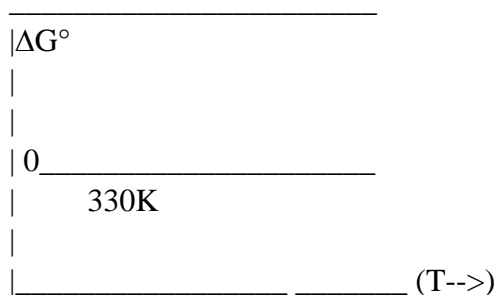


$$\Delta G = -(-.42)(1)F ; \text{ (ii) } \Delta G = -(-.89)(2)F : \Delta G_{\text{net}} = -2.2F : \Delta E^\circ_{\text{net}} = -2.2/3 = -0.73\text{V}$$

17. a) expect $\Delta S^\circ > 0$ (i.e. positive) since we are converting from a liquid phase (i.e. Hg(l)) to a dissolved phase (i.e. $\text{Hg}_2^{2+}(\text{aq})$).

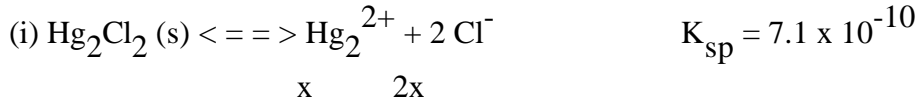
b) ΔH° is positive. if the $\Delta E^\circ = 0$ that means $\Delta G = 0$. The graph has a negative slope crossing at 330 K. It must have a positive ΔH° to be able to cross the $\Delta G^\circ = 0$ and still have a negative slope.

Draw a graph of ΔG° vs T for this redox reaction.



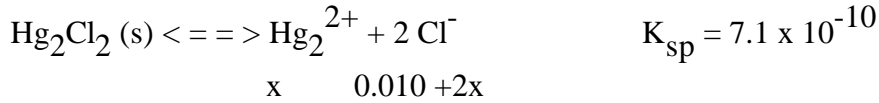
18) solution: write the relevant K_{sp} equilibria:

a) in H_2O



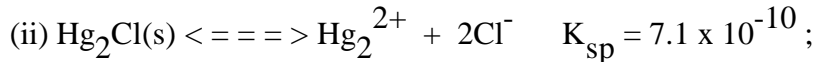
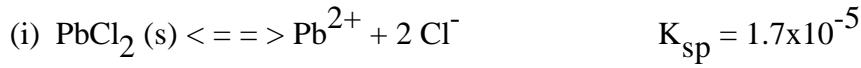
$x(2x)^2 = 7.1 \times 10^{-10} \Rightarrow x = 5.6 \times 10^{-4} \text{ M}$

b) Note same equation:

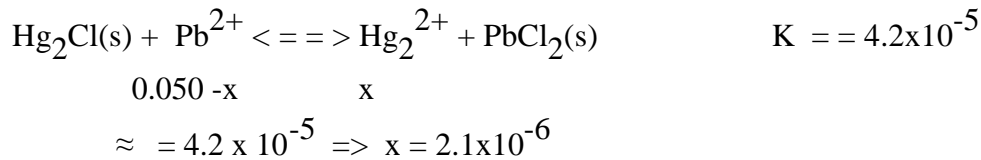


common ion effect: $(x)(0.010+2x)^2 \approx (x)(0.010)^2 = 7.1 \times 10^{-10} \Rightarrow x = 7.1 \times 10^{-6} \text{ M}$
 we note: $= 0.071\% < 5\%$

c) Here we need to consider 2 equilibria:



Need to do: -(i) + (ii):

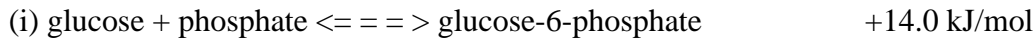


Note: $= 4.2 \times 10^{-3} \% < 5\%$

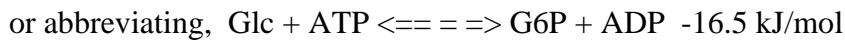
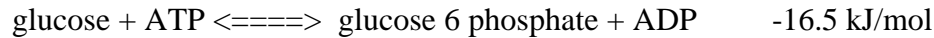
19.

a) solution:

by coupling the 2 reactions. (i) - (ii)



we get the net reaction:



$K_{\text{net}} = \exp(-16.5/RT) = 780$

without coupling the 2 reactions, we'd just use equation (i) by itself:

$K_1 = [\text{G6P}]/[\text{Glc}][\text{P}_i] = \exp(-14.0/RT) = 0.0035$

$K_{\text{net}}/K_1 = 780/0.0035 = 220,000! \text{ times!} =$

(here we assumed that $[\text{P}_i] = 1$ (standard condition))

$$\text{b) } \ln K_2 = -(\Delta H - T_2 \Delta S) / R = (+) =$$

similarly,

$$\ln K_1 = -(\Delta H - T_1 \Delta S) / R = (+) =$$

$$\text{Subtracting: } \ln K_2 - \ln K_1 = (-) - (-) = (-) - (-)$$

$$\text{Or, } \Delta H = R \ln (K_2 / K_1) = (8.314) (\ln (0.1 / 0.01))$$

$$= (8.314) (2.101) (142.5) = 5.68 \times 10^4 \text{ J/mol} = 56.8 \text{ kJ/mol}$$