Chem 210 – Exam 4b *Name:* _____

Spring 2010

Chemistry 210 Exam 4

Be sure to put your name on each page. This page can be removed from your exam so that you will have a Periodic Table handy throughout the exam, it does not need to be turned in. Show all your work for problems which require any sort of calculation, no credit will be given for answers without work shown. If you have shown a significant amount of work or multiple drawings for a problem, draw a box around what you consider your final answer.

Avogadro's Number = $6.022 \times 10^{23}\ ^{\text{units}}/_{\text{mo}}$

$32.00^{\circ}\text{F} = 0.000^{\circ}\text{C} = 273.15\text{K}$

Density of Water = $1.000\ ^{\text{g}}/_{\text{mL}}$

$R = 0.08206\ ^{\text{L•atm}}/_{\text{mol•K}} = 8.314\ ^{\text{J}}/_{\text{mol•K}}$

$PV=nRT$

$\Delta T_{fp/bp} = k_{fp/bp} \bullet m \bullet i$

For water, $k_{fp} = -1.86\ ^{^{\circ}\text{C}}/_{\text{m}}$; $k_{bp} = 0.52\ ^{^{\circ}\text{C}}/_{\text{m}}$

$P_1 = X_1 P_1^{\circ}$

$P = cRTi$

$C_1V_1 = C_2V_2$

Quadratic formula:

$$x = \frac{-b \pm \sqrt{b^2 - 4ac}}{2a}$$

Integrated Rate Laws:

$$\ln[A]_t = -kt + \ln[A]_o$$

$$1/[A]_t = kt + 1/[A]_o$$

$$[A]_t = -kt + [A]_o$$

$k = Ae^{-Ea/RT}$

$$\ln(k) = \left(\frac{-E_a}{R}\right)\left(\frac{1}{T}\right) + \ln(A)$$

$$\ln\left(\frac{k_1}{k_2}\right) = \frac{E_a}{R}\left(\frac{1}{T_2} - \frac{1}{T_1}\right)$$

$$pH = pK_a + \log\left(\frac{[\text{conjugate base}]}{[\text{conjugate acid}]}\right)$$

$E_{cell} = E^{\circ}_{cell} - {}^{RT}/_{nF}\ lnQ$

$E^{\circ}_{cell} = {}^{RT}/_{nF}\ lnK^{\circ}$

$K^{\circ} = e\text{^}({}^{nF}/_{RT}\ E^{\circ}_{cell})$

$F = 96485\ ^{\text{J}}/_{\text{V•mol of electrons}}$

$\Delta G^{\circ} = \Delta H^{\circ}_{system} - T\Delta S^{\circ}_{system}$

$\Delta G^{\circ} = -nFE^{\circ}_{cell} = -RTlnK^{\circ}$

$\Delta G = \Delta G^{\circ} + RTlnQ$

$F = 96485\ ^{\text{C}}/_{\text{mol electrons}}$

$1A = 1\ C / sec$

1 **H** 1.0079																	2 **He** 4.0026
3 **Li** 6.941	4 **Be** 9.0122											5 **B** 10.811	6 **C** 12.011	7 **N** 14.007	8 **O** 15.999	9 **F** 18.998	10 **Ne** 20.180
11 **Na** 22.990	12 **Mg** 24.305											13 **Al** 26.982	14 **Si** 28.086	15 **P** 30.974	16 **S** 32.066	17 **Cl** 35.453	18 **Ar** 39.948
19 **K** 39.098	20 **Ca** 40.078	21 **Sc** 44.956	22 **Ti** 47.88	23 **V** 50.942	24 **Cr** 51.996	25 **Mn** 54.938	26 **Fe** 55.847	27 **Co** 58.933	28 **Ni** 58.69	29 **Cu** 63.546	30 **Zn** 65.39	31 **Ga** 69.723	32 **Ge** 72.61	33 **As** 74.922	34 **Se** 78.96	35 **Br** 79.904	36 **Kr** 83.80
37 **Rb** 85.468	38 **Sr** 87.62	39 **Y** 88.906	40 **Zr** 91.224	41 **Nb** 92.906	42 **Mo** 95.94	43 **Tc** (98)	44 **Ru** 101.07	45 **Rh** 102.91	46 **Pd** 106.42	47 **Ag** 107.87	48 **Cd** 112.41	49 **In** 114.82	50 **Sn** 118.71	51 **Sb** 121.76	52 **Te** 127.60	53 **I** 126.90	54 **Xe** 131.29
55 **Cs** 132.91	56 **Ba** 137.33	57 **La** 138.91	72 **Hf** 178.49	73 **Ta** 180.95	74 **W** 183.84	75 **Re** 186.21	76 **Os** 190.23	77 **Ir** 192.22	78 **Pt** 195.08	79 **Au** 196.97	80 **Hg** 200.59	81 **Tl** 204.38	82 **Pb** 207.2	83 **Bi** 208.98	84 **Po** (209)	85 **At** (210)	86 **Rn** (222)
87 **Fr** (223)	88 **Ra** 226.03	89 **Ac** 227.03	104 **Rf** (261)	105 **Db** (262)	106 **Sg** (263)	107 **Bh** (262)	108 **Hs** (265)	109 **Mt** (266)	110 (269)	111 (272)	112 (277)		114		116		

58 **Ce** 140.12	59 **Pr** 140.91	60 **Nd** 144.24	61 **Pm** (145)	62 **Sm** 150.36	63 **Eu** 151.97	64 **Gd** 157.25	65 **Tb** 158.93	66 **Dy** 162.50	67 **Ho** 164.93	68 **Er** 167.26	69 **Tm** 168.94	70 **Yb** 173.04	71 **Lu** 174.97
90 **Th** 232.04	91 **Pa** 231.04	92 **U** 238.03	93 **Np** 237.05	94 **Pu** (244)	95 **Am** (243)	96 **Cm** (247)	97 **Bk** (247)	98 **Cf** (251)	99 **Es** (252)	100 **Fm** (258)	101 **Md** (258)	102 **No** (259)	103 **Lr** (260)

Score

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Multiple Choice (5pts each)

1. The symbol ΔS represents:
   a. Change in entropy
   b. Change in solubility
   c. Change in enthalpy
   d. Change in free energy
   e. Change in time

2. A small positive change in free energy means:
   a. The reaction is very slow
   b. The reaction is endothermic
   c. The reaction is not spontaneous
   d. The system is becoming more disordered
   e. The reaction is spontaneous

3. For a reaction with a large negative ΔS:
   a. Heat is required to make the reaction proceed
   b. The system is becoming much more ordered
   c. The reaction is not spontaneous
   d. The disorder of the system is increasing
   e. The reaction proceeds very slowly

4. A reaction will be product-favored/spontaneous/naturally occurring if:
   a. $\Delta G^o < 0$
   b. $K_{eq} < 1$
   c. $\Delta H > 0$
   d. $\Delta S^o < 0$
   e. $K_{eq} < 0$

5. A reaction will be spontaneous at all temperature if:
   a. $\Delta H^o_{system} > 0$ and $\Delta S^o_{system} > 0$
   b. $\Delta H^o_{system} = 0$ and $\Delta S^o_{system} > 0$
   c. $\Delta H^o_{system} > 0$ and $\Delta S^o_{system} = 0$
   d. $\Delta H^o_{system} > 0$ and $\Delta S^o_{system} < 0$
   e. $\Delta H^o_{system} < 0$ and $\Delta S^o_{system} < 0$

6. If the change in enthalpy for a reaction is positive and the change in entropy is negative:
   a. The reaction releases heat
   b. The reaction will never be spontaneous
   c. The system is becoming more disordered
   d. The reaction will always be spontaneous
   e. The reaction will be spontaneous only at low temperatures

7. How are the change in Gibb's Free Energy and the equilibrium constant for a reaction related?
   a. As K approaches zero, ΔG approaches zero
   b. They're not.
   c. The value of ΔG is equal to (-logK)
   d. As ΔG gets more positive, K approaches 1
   e. As ΔG gets more negative, K gets very large

Score

8. For each of the following reactions, predict the sign of $\Delta S°$ and explain your answer (6pts each):

$$Fe^{3+}(aq) + 4\ Cl^{-}(aq) \Leftrightarrow [Fe(Cl)_4]^{-}(aq)$$

$$PbCl_2(s) \Leftrightarrow PbCl_2(aq)$$

$$Ni(NO_3)_2(aq) + K_2CrO_4(aq) \Leftrightarrow NiCrO_4(s) + 2\ KNO_3(aq)$$

9. You are studying the reaction of aspirin $\{C_9H_8O_4(s)\}$ with caffeine $\{C_8H_{10}N_4O_2(s)\}$ to produce aspeine $\{C_9H_{10}N_2O_3(s)\}$ and caffirin $\{C_8H_8N_2O_3(s)\}$. The temperature in your laboratory is 22.63ºC and you find that ΔG for this reaction is -11.18 $^{kJ}/_{mol}$. You have also determined that for this reaction ΔS = +94.85 $^{J}/_{mol \cdot K}$ (20pts)
   a. Is the reaction endothermic or exothermic? (*Explain your answer with explicit calculations.*)

   b. Over what temperature range is this reaction spontaneous?

Score

10. Propane {$C_3H_8(g)$} reacts with oxygen gas in gas grills to produce carbon dioxide gas, water gas and heat. How much energy is released by burning 58.371g of propane in an unlimited supply of oxygen? If all of this energy is used to decompose silver chloride solid to chlorine gas and silver metal, how many grams of silver metal can be produced? (25pts)

11. You would like to plate 2.46g of platinum (atomic # = 78) using an electrolytic cell containing a solution of platinum(II) nitrate and operating at 5.81A. How long will you have to run the cell? (15pts)

Score

12. For each of the following pairs of half-reactions/half-cells, determine the voltage of the spontaneous reaction/cell and write a balanced equation for the reaction that occurs, identifying the oxidation and reduction half-reactions. (20pts each)

$La^{3+}|La$ and $Sn^{4+}|Sn^{2+}$

$HClO|Cl_2$ and $NO_3^-|NO$

Thermodynamic Values at 25ºC:

Substance	**ΔH^o_f ($^{kJ}/_{mol}$)**	**S^o ($^{J}/_{mol \cdot K}$)**	**ΔG^o_f ($^{kJ}/_{mol}$)**
$C_3H_8(g)$	-103.85	270.3	-23.4
$O_2(g)$	0	205.138	0
$CO_2(g)$	-393.509	213.74	-394.359
$H_2O(g)$	-241.8	188.8	-228.6
AgCl(s)	-127.0	96.3	-109.8
$Cl_2(g)$	0	223.1	0
Ag(s)	0	42.6	0

Standard Reduction Potentials at 25ºC:

Half cell	**E^o_{red} (volts)**	**Half cell**	**E^o_{red} (volts)**
$Pt^{2+}(aq)|Pt(s)$	+0.76	$HClO(aq)|Cl_2(g)$	+1.61
$La^{3+}(aq)|La(s)$	-2.38	$NO_3^-(aq)|NO(g)$	+0.96
$Sn^{4+}(aq)|Sn^{2+}(aq)$	+0.15		

Score