Name (please print)

CHEMISTRY 128
HOUR TEST 3
June 27, 2003

USEFUL INFORMATION:

$R = 8.314$ J/K*mole

1 amp $= 1$ C/s

$F = 96{,}500$ C/mol

$\Delta S_{surroundings} = -\Delta H/T$

$\Delta S^o_{system} = \Sigma S^o_{prod} - \Sigma S^o_{react}$

$\Delta H^o_{reaction} = \Sigma H^o_{prod} - \Sigma H^o_{react}$

$\Delta G^o_{reaction} = \Sigma G^o_{prod} - \Sigma G^o_{react}$

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

$\Delta G_{system} = \Delta G^o_{system} - RT\ln Q$

$\Delta G^o_{system} = -RT\ln K$

$E^o_{cell} = E^o_{red} + E^o_{ox}$

$\Delta G^o_{system} = -nFE^o_{cell}$

$E_{cell} = E^o_{cell} - (0.0592/n)\log Q$

$\log K = (nE^o_{cell})/0.0592$

1 IA																	18 VIIIA
1 **H** 1.008	2 IIA											13 IIIA	14 IVA	15 VA	16 VIA	17 VIIA	2 **He** 4.00
3 **Li** 6.94	4 **Be** 9.01											5 **B** 10.81	6 **C** 12.01	7 **N** 14.01	8 **O** 16.00	9 **F** 19.00	10 **Ne** 20.18
11 **Na** 22.99	12 **Mg** 24.31	3 IIIB	4 IVB	5 VB	6 VIB	7 VIIB	8 ⌐	9 VIIIB	10 ¬	11 IB	12 IIB	13 **Al** 26.98	14 **Si** 28.09	15 **P** 30.97	16 **S** 32.06	17 **Cl** 35.45	18 **Ar** 39.95
19 **K** 39.10	20 **Ca** 40.08	21 **Sc** 44.96	22 **Ti** 47.88	23 **V** 50.94	24 **Cr** 52.00	25 **Mn** 54.94	26 **Fe** 55.85	27 **Co** 58.93	28 **Ni** 58.71	29 **Cu** 63.54	30 **Zn** 65.37	31 **Ga** 69.72	32 **Ge** 72.59	33 **As** 74.92	34 **Se** 78.96	35 **Br** 79.91	36 **Kr** 83.30
37 **Rb** 85.47	38 **Sr** 87.62	39 **Y** 88.91	40 **Zr** 91.22	41 **Nb** 92.91	42 **Mo** 95.94	43 **Tc** 98.91	44 **Ru** 101.07	45 **Rh** 102.91	46 **Pd** 106.4	47 **Ag** 107.87	48 **Cd** 112.40	49 **In** 114.82	50 **Sn** 118.69	51 **Sb** 121.75	52 **Te** 127.60	53 **I** 126.90	54 **Xe** 131.30
55 **Cs** 132.91	56 **Ba** 137.34	71 **Lu** 174.97	72 **Hf** 178.49	73 **Ta** 180.95	74 **W** 183.85	75 **Re** 186.2	76 **Os** 190.2	77 **Ir** 192.2	78 **Pt** 195.09	79 **Au** 196.97	80 **Hg** 200.59	81 **Tl** 204.37	82 **Pb** 207.19	83 **Bi** 208.98	84 **Po** 210	85 **At** 210	86 **Rn** 222
87 **Fr** 223	88 **Ra** 226.03	103 **Lr** 262.1	104 **Rf**	105 **Db**	106 **Sg**	107 **Bh**	108 **Hs**	109 **Mt**									

57 **La** 138.91	58 **Ce** 140.12	59 **Pr** 140.91	60 **Nd** 144.24	61 **Pm** 146.92	62 **Sm** 150.35	63 **Eu** 151.96	64 **Gd** 157.25	65 **Tb** 158.92	66 **Dy** 162.50	67 **Ho** 164.93	68 **Er** 167.26	69 **Tm** 168.93	70 **Yb** 173.04
89 **Ac** 227.03	90 **Th** 232.04	91 **Pa** 231.04	92 **U** 238.03	93 **Np** 237.05	94 **Pu** 239.05	95 **Am** 241.06	96 **Cm** 247.07	97 **Bk** 249.08	98 **Cf** 251.08	99 **Es** 254.09	100 **Fm** 257.10	101 **Md** 258.10	102 **No** 255

There Are <u>7</u> Pages On This Test Including This Cover Page.
The Test Contains <u>100</u> Points.

Part I. (44 points) Short Answers

1. A bottle of liquid bromine contains a considerable volume of bromine vapor at room temperature.

   a. Write a balanced chemical equation for the vaporization of liquid bromine.

   b. ΔH is (**positive, zero, negative**) for the vaporization of liquid bromine

   c. ΔS is (**positive, zero, negative**) for the vaporization of liquid bromine

   d. The vaporization is (**less, more**) favorable as the temperature is raised.

2. The Third Law of Thermodynamics deals with (**Gibb's Free energy, enthalpy , entropy**).

3. The First Law of Thermodynamics deals with (**Gibb's Free energy, generic energy , entropy**).

4. What type of molecular motion is the extension and compression of a chemical bond?

   _____ motion

5. In Na_2SO_4 the oxidation state of Na is (**+6, +3, +1, – 1, -3, -6**) and the oxidation state of S is (**+6, +3, +1, – 1, -3, -6**) .

6. The oxidation state of N in NO_2 is (**more positive than, the same as, less positive than**) the oxidation state of N in N_2 and would therefore need to be (**oxidized, reduced**) to be converted into N_2.

7. Considering the following half-reactions:

   $Mg^{2+} + 2\ e^- \rightarrow Mg\ (s)$ $\quad E^o_{red} = -2.37$ V
   $Al^{3+} + 3\ e^- \rightarrow Al\ (s)$ $\quad E^o_{red} = -1.66$ V

   a. Which species is most easily oxidized (at standard conditions)? _____

   b. Which species is the strongest oxidizing agent (at standard conditions)? _____

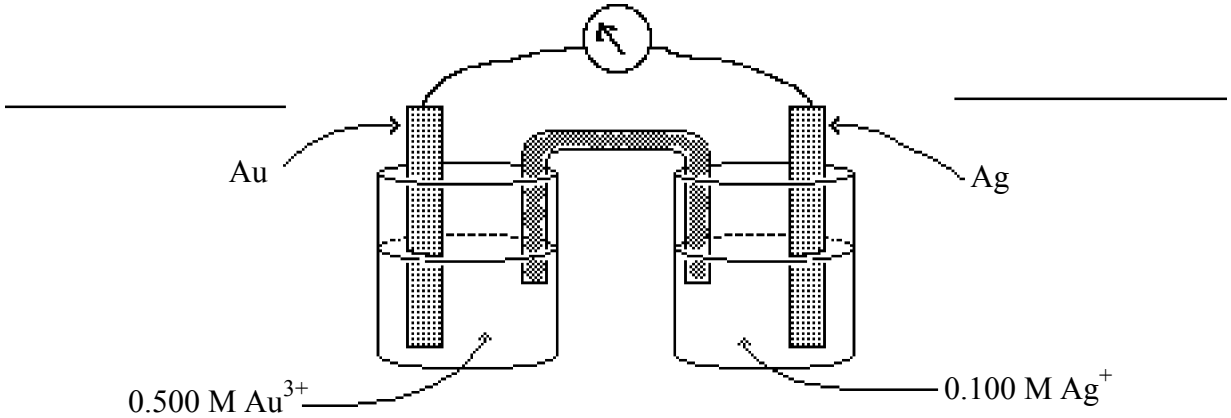
8. On the cell diagram below:

   a. Label the cathode and the anode.

   b. Use an arrow to indicate the direction in which electrons will flow.

$Ag^{+}(aq) + 1\ e^{-} \rightarrow Ag(s)$ $\quad E^{o}_{red} = 0.80\ V$

$Au^{3+}(aq) + 3\ e^{-} \rightarrow Au(s)$ $\quad E^{o}_{red} = 1.50\ V$



Part II. (8 points) Balance the following reaction that occurs in acid: (show method clearly for full credit)

$$Cr_2O_7^{2-}(aq) + Fe^{2+}(aq) \rightarrow Cr^{3+}(aq) + Fe^{3+}(aq)$$

Part III. Problems (48 points) **Show all calculations for full credit**. No calculations, no credit.

10. (12 points) What mass (in grams) of solid $Pb(OH)_2$ ($K_{sp} = 1.40 \times 10^{-15}$) will dissolve in 0.750 L of an aqueous solution that has a pH of 11.35.

11. (14 points) Consider the following reaction:

$$8\ H_2S\ (g)\ +\ 4\ O_2\ (g) \leftrightarrow 8\ H_2O\ (l) +\ S_8\ (s) \qquad \Delta H^o_{rxn} = -2122\ kJ$$

Given the following information, determine the ΔG^o_f (in kJ/mol) of H_2S (g) at 25.0°C.

Species	S^o (J/mol.K)	ΔG^o_f (kJ/mol)
H_2S (g)	205.8	???
O_2 (g)	205.2	0.000
H_2O (l)	69.95	-237.1
S_8 (s)	256.8	0.000

12. (14 Points) Consider the following electrochemical cell at 25°C.

$$Al(s) \mid Al^{3+} (???? M) \parallel Fe^{2+} (0.50 M) \mid Fe (s)$$

$Al^{3+} (aq) + 3 e^- \rightarrow Al (s)$ $\quad E^o_{red} = -1.660$ V

$Fe^{2+} (aq) + 2 e^- \rightarrow Fe (s)$ $\quad E^o_{red} = -0.440$ V

a. Write the balanced equation for this cell as it is written.

b. Calculate the ε°_{cell} for the cell as it is written.

c. The cell potential (ε_{cell}) was experimentally measured to be 1.240 V. Determine the $[Al^{3+}]$ (in M).

d. Calculate the value of ΔG^o (in kJ) for the reaction of this cell.

e. Does this reaction favor the formation of products or reactants?

13. (8 points) Chlorine is produced commerically by the electrolysis of aqueous sodium chloride. The anodic reaction is

$$2\ Cl^-\ (aq) \rightarrow Cl_2\ (g) + 2\ e^-$$

If a current of 53.7 A is used, how much time (in hours) is required to produce 355 g of Cl_2?