CHEMISTRY 123 – SPRING 2011
STOLTZFUS MIDTERM EXAM #2

Wednesday, May 18th, 2011. 6:30 pm – 7:18 pm
Time Limit: 1 hour 18 minutes

Your scan sheet must be completed using a PENCIL only and is to be turned in to your TA at the end of the exam period. **You may keep your exam booklet.**

Only approved Calculators are to be used – all other electronic devices are forbidden.

When the TA gives the signal, but not before, check to see that all 12 numbered pages, containing 25 questions, an equation sheet, K_{sp}, K_f, and periodic tables, and 2 pages of scrap paper are present.

Only your marks written on the answer sheet will be graded, not the answer booklet. You will not be given extra time to transfer your answers to the answer sheet.

Take out your Buck-ID and fill in your scan sheet with ONLY this information:

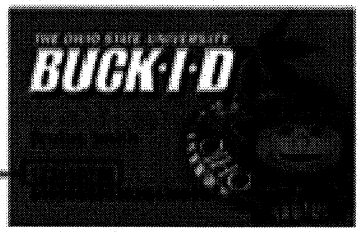
1. Write/bubble in your **last, first, middle initial**; each separated by a space
2. Starting in column A, fill in your 9 or 10 digit SIS ID # (aka Carmen ID #)
3. Fill in your section number in columns K-L based on your section by lab TA
4. Sign the top of the scan sheet above your name

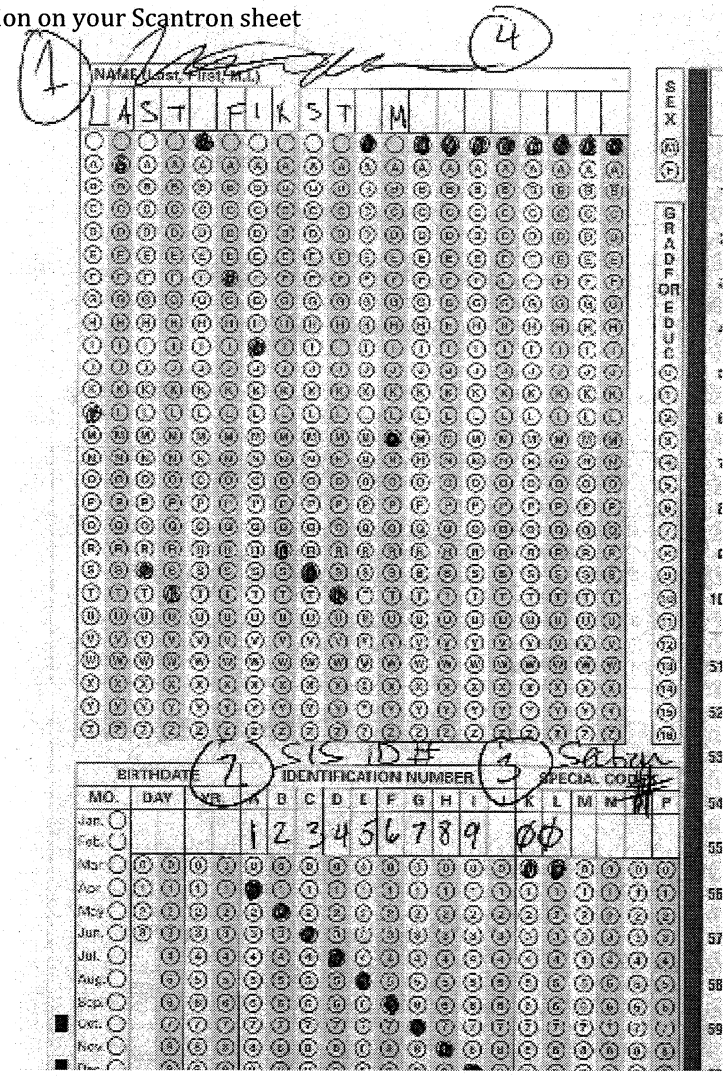
Please, do not provide any additional information on your Scantron sheet

Section number
Enter in your lab TA

Bryan Albani	=	77
Martin Beres	=	78
Xin Yang	=	79
Minette Ocampo	=	80
Wei Hua	=	81
Tian Lu	=	82
Min Gao	=	97
Mark Haverick	=	98
Joselyn Del-Pilar	=	99
Tushar Kabre	=	00
Jeff Joyner	=	01
Thi Trinh	=	02

SIS/CARMEN ID # (Note: may not be on older Buck-IDs)





Spectrochemical series

$I^- < Br^- < Cl^- < F^- < H_2O < NH_3 < en < NO_2^-$ (N-bonded) $< CN^- < CO$

Solubility Tables:

Water soluble compounds contain:	Exceptions:
Acetate	None
Nitrate	None
Iodide, Bromide, and Chloride	Compounds of Ag^+, Hg_2^{2+}, and Pb^{2+}
Sulfate	Compounds of Sr^{2+}, Ba^{2+},Hg_2^{2+}, and Pb^{2+}

Water insoluble compounds contain:	Exceptions:
Sulfide, Hydroxide	Compounds of the alkali metal cations, Ca^{2+}, Sr^{2+}, Ba^{2+}, and NH_4^+
Carbonate, Phosphate	Compounds of the alkali metal cations, and NH_4^+

Useful equations:

$K_w=[H^+][OH^-]$ ($K_w = 1.00\text{x}10^{-14}$ at 25°C), $K_aK_b=K_w$

$pX = -\log [X]$, $[X] = 10^{-pX}$, $\log(xy) = \log x + \log y$

$S = k_B \ln W$, $\Delta G = \Delta H - T\Delta S$, $\Delta G = \Delta G^\circ + RT \ln Q$, $\Delta G = -RT \ln K$

$E^\circ_{cell} = E^\circ_{red}$ (cathode) $- E^\circ_{red}$ (anode), $\Delta G = -nFE_{cell}$, $E_{cell} = E^\circ_{cell} - \frac{0.0592V}{n} \log Q$

$N_A = 6.022 \text{ x } 10^{23}$, $R = 8.314$ J/mol·K $= 0.08206$ L·atm/mol·K

$c = 2.998 \text{ x } 10^8$ m/s, $h = 6.626 \text{ x } 10^{-34}$ J-s, $1\ e^- = 1.60 \text{ x } 10^{-19}$ C

1 V = 1 J / 1 C, 1 W = 1 J / 1 s, $1 \text{ kW·h} = 3.6\text{x}10^6$ J

F = 96,485 J/V·mol = 96,486 C/mol e^-

$t_{1/2} = 0.693/k$ (first order), $\ln[A]_t - \ln[A]_0 = -kt$ (first order)

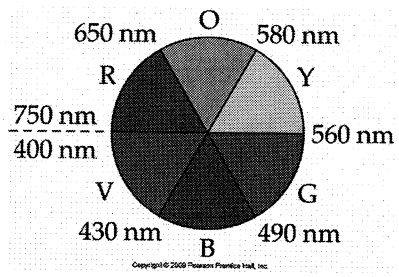
$\ln K = -\Delta H^\circ/R(1/T) + C$

Table of solubility product constants at 25°C

Substance	K_{sp}
AgBr	5.4×10^{-13}
AgCl	1.8×10^{-10}
AgI	8.5×10^{-17}
Ag_2CO_3	8.1×10^{-12}
Ag_2CrO_4	1.1×10^{-12}
Ag_3PO_4	8.9×10^{-17}
Ag_2S*	6.7×10^{-50}
Ag_2SO_4	1.2×10^{-5}
$Al(OH)_3$	1.8×10^{-33}
$AlPO_4$	9.8×10^{-21}
$BaCO_3$	2.6×10^{-9}
$BaCrO_4$	1.2×10^{-10}
BaF_2	1.8×10^{-7}
$Ba_3(PO_4)_2$	1.3×10^{-29}
$BaSO_4$	1.1×10^{-10}
$Bi(OH)_3$	3.2×10^{-40}
$BiPO_4$	1.3×10^{-23}
Bi_2S_3*	1.8×10^{-99}
$CaCO_3$	5.0×10^{-9}
CaF_2	1.5×10^{-10}
$Ca(OH)_2$	5.0×10^{-6}
$Ca_3(PO_4)_2$	2.1×10^{-33}
$CaSO_4$	7.1×10^{-5}
$Cd(OH)_2$	2.5×10^{-14}
$CoCO_3$	8.0×10^{-13}
$Co(OH)_2$	1.1×10^{-15}
$Co_3(PO_4)_2$	2.1×10^{-35}
CoS*	4.0×10^{-21}
$Cr(OH)_3$	3.0×10^{-29}
$Cr_3(PO_4)_2$	2.4×10^{-23}
$CuCO_3$	2.5×10^{-10}
$Cu(OH)_2$	2.2×10^{-20}
$Cu_3(PO_4)_2$	1.4×10^{-37}
CuS*	1.3×10^{-36}

Substance	K_{sp}
$FeCO_3$	3.1×10^{-11}
$Fe(OH)_2$	4.9×10^{-17}
$Fe(OH)_3$	2.6×10^{-39}
FeS*	1.6×10^{-19}
Hg_2SO_4	6.5×10^{-7}
$Mg(OH)_2$	1.8×10^{-11}
MnS*	3.0×10^{-14}
$NiCO_3$	1.4×10^{-7}
$Ni(OH)_2$	2.8×10^{-16}
NiS*	1.1×10^{-21}
$PbBr_2$	6.3×10^{-6}
$PbCl_2$	1.7×10^{-5}
PbI_2	9.8×10^{-9}
$PbCO_3$	1.5×10^{-13}
$PbCrO_4$	1.8×10^{-14}
$Pb(OH)_2$	1.4×10^{-20}
PbS*	9.0×10^{-29}
$PbSO_4$	1.8×10^{-8}
Sb_2S_3*	1.6×10^{-93}
SnS*	1.0×10^{-26}
$ZnCO_3$	1.2×10^{-10}
$Zn(OH)_2$	3.0×10^{-16}
$Zn_3(PO_4)_2$	9.1×10^{-33}
ZnS*	2.9×10^{-25}

*For the reaction: M_nS_m (s) + m H_2O (l) ⟶ n M^{m+} + m SH^- (aq) + m OH^- (aq)



Violet	400-430 nm
Blue	430-490 nm
Green	490-560 nm
Yellow	560-580 nm
Orange	580-650 nm
Red	650-750 nm

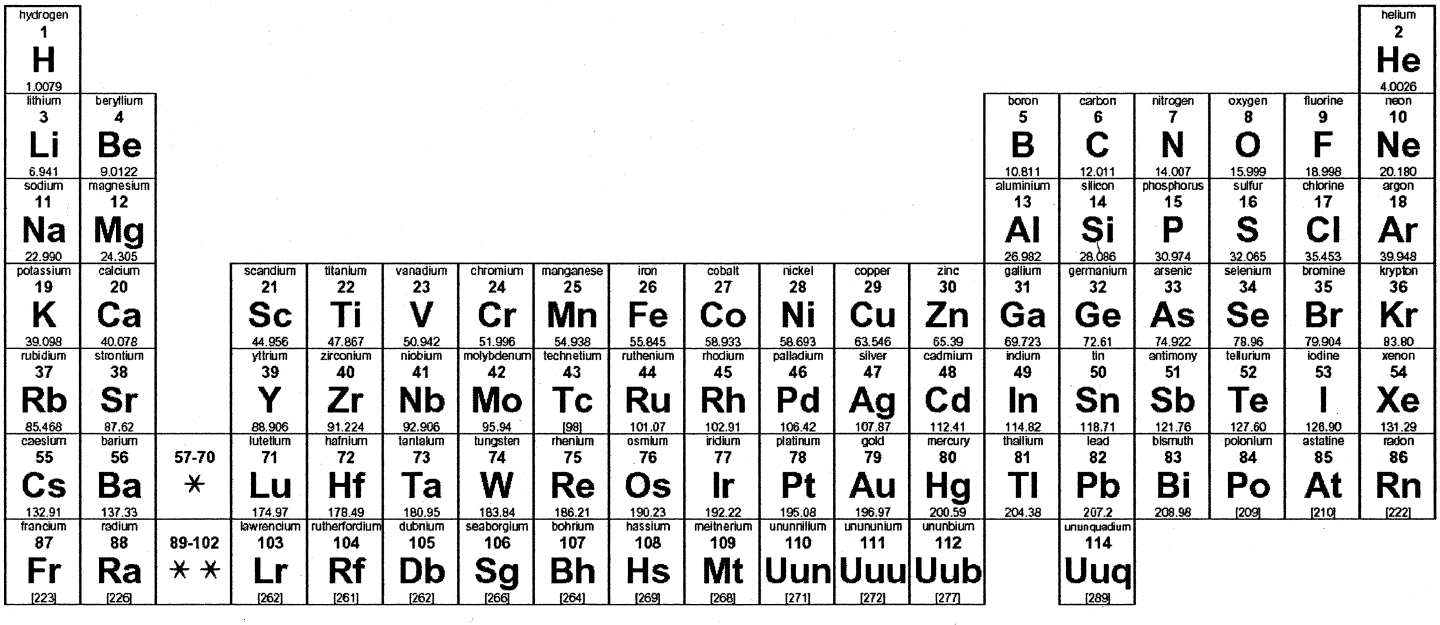
APPENDIX E

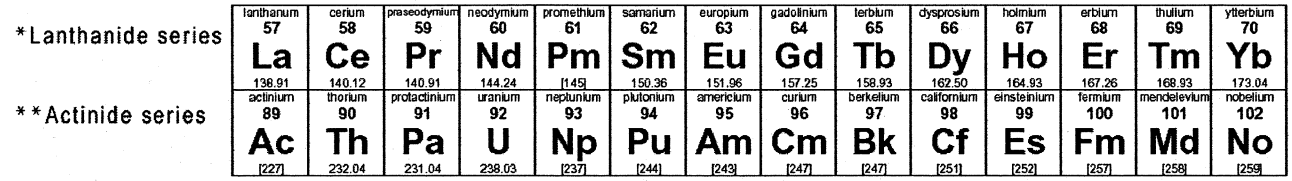
Standard Reduction Potentials at 25 °C

Half-Reaction	$E°$(V)
$Ag^+(aq) + e^- \longrightarrow Ag(s)$	+0.799
$AgBr(s) + e^- \longrightarrow Ag(s) + Br^-(aq)$	+0.095
$AgCl(s) + e^- \longrightarrow Ag(s) + Cl^-(aq)$	+0.222
$Ag(CN)_2^-(aq) + e^- \longrightarrow Ag(s) + 2\,CN^-(aq)$	−0.31
$Ag_2CrO_4(s) + 2\,e^- \longrightarrow 2\,Ag(s) + CrO_4^{2-}(aq)$	+0.446
$AgI(s) + e^- \longrightarrow Ag(s) + I^-(aq)$	−0.151
$Ag(S_2O_3)_2^{3-}(aq) + e^- \longrightarrow Ag(s) + 2\,S_2O_3^{2-}(aq)$	+0.01
$Al^{3+}(aq) + 3\,e^- \longrightarrow Al(s)$	−1.66
$H_3AsO_4(aq) + 2\,H^+(aq) + 2\,e^- \longrightarrow H_3AsO_3(aq) + H_2O(l)$	+0.559
$Ba^{2+}(aq) + 2\,e^- \longrightarrow Ba(s)$	−2.90
$BiO^+(aq) + 2\,H^+(aq) + 3\,e^- \longrightarrow Bi(s) + H_2O(l)$	+0.32
$Br_2(l) + 2\,e^- \longrightarrow 2\,Br^-(aq)$	+1.065
$2\,BrO_3^-(aq) + 12\,H^+(aq) + 10\,e^- \longrightarrow Br_2(l) + 6\,H_2O(l)$	+1.52
$2\,CO_2(g) + 2\,H^+(aq) + 2\,e^- \longrightarrow H_2C_2O_4(aq)$	−0.49
$Ca^{2+}(aq) + 2\,e^- \longrightarrow Ca(s)$	−2.87
$Cd^{2+}(aq) + 2\,e^- \longrightarrow Cd(s)$	−0.403
$Ce^{4+}(aq) + e^- \longrightarrow Ce^{3+}(aq)$	+1.61
$Cl_2(g) + 2\,e^- \longrightarrow 2\,Cl^-(aq)$	+1.359
$2\,HClO(aq) + 2\,H^+(aq) + 2\,e^- \longrightarrow Cl_2(g) + 2\,H_2O(l)$	+1.63
$ClO^-(aq) + H_2O(l) + 2\,e^- \longrightarrow Cl^-(aq) + 2\,OH^-(aq)$	+0.89
$2\,ClO_3^-(aq) + 12\,H^+(aq) + 10\,e^- \longrightarrow Cl_2(g) + 6\,H_2O(l)$	+1.47
$Co^{2+}(aq) + 2\,e^- \longrightarrow Co(s)$	−0.277
$Co^{3+}(aq) + e^- \longrightarrow Co^{2+}(aq)$	+1.842
$Cr^{3+}(aq) + 3\,e^- \longrightarrow Cr(s)$	−0.74
$Cr^{3+}(aq) + e^- \longrightarrow Cr^{2+}(aq)$	−0.41
$CrO_7^{2-}(aq) + 14\,H^+(aq) + 6\,e^- \longrightarrow 2\,Cr^{3+}(aq) + 7\,H_2O(l)$	+1.33
$CrO_4^{2-}(aq) + 4\,H_2O(l) + 3\,e^- \longrightarrow Cr(OH)_3(s) + 5\,OH^-(aq)$	−0.13
$Cu^{2+}(aq) + 2\,e^- \longrightarrow Cu(s)$	+0.337
$Cu^{2+}(aq) + e^- \longrightarrow Cu^+(aq)$	+0.153
$Cu^+(aq) + e^- \longrightarrow Cu(s)$	+0.521
$CuI(s) + e^- \longrightarrow Cu(s) + I^-(aq)$	−0.185
$F_2(g) + 2\,e^- \longrightarrow 2\,F^-(aq)$	+2.87
$Fe^{2+}(aq) + 2\,e^- \longrightarrow Fe(s)$	−0.440
$Fe^{3+}(aq) + e^- \longrightarrow Fe^{2+}(aq)$	+0.771
$Fe(CN)_6^{3-}(aq) + e^- \longrightarrow Fe(CN)_6^{4-}(aq)$	+0.36
$2\,H^+(aq) + 2\,e^- \longrightarrow H_2(g)$	0.000
$2\,H_2O(l) + 2\,e^- \longrightarrow H_2(g) + 2\,OH^-(aq)$	−0.83
$HO_2^-(aq) + H_2O(l) + 2\,e^- \longrightarrow 3\,OH^-(aq)$	+0.88
$H_2O_2(aq) + 2\,H^+(aq) + 2\,e^- \longrightarrow 2\,H_2O(l)$	+1.776
$Hg_2^{2+}(aq) + 2\,e^- \longrightarrow 2\,Hg(l)$	+0.789
$2\,Hg^{2+}(aq) + 2\,e^- \longrightarrow Hg_2^{2+}(aq)$	+0.920
$Hg^{2+}(aq) + 2\,e^- \longrightarrow Hg(l)$	+0.854
$I_2(s) + 2\,e^- \longrightarrow 2\,I^-(aq)$	+0.536
$2\,IO_3^-(aq) + 12\,H^+(aq) + 10\,e^- \longrightarrow I_2(s) + 6\,H_2O(l)$	+1.195
$K^+(aq) + e^- \longrightarrow K(s)$	−2.925
$Li^+(aq) + e^- \longrightarrow Li(s)$	−3.05
$Mg^{2+}(aq) + 2\,e^- \longrightarrow Mg(s)$	−2.37
$Mn^{2+}(aq) + 2\,e^- \longrightarrow Mn(s)$	−1.18
$MnO_2(s) + 4\,H^+(aq) + 2\,e^- \longrightarrow Mn^{2+}(aq) + 2\,H_2O(l)$	+1.23
$MnO_4^-(aq) + 8\,H^+(aq) + 5\,e^- \longrightarrow Mn^{2+}(aq) + 4\,H_2O(l)$	+1.51
$MnO_4^-(aq) + 2\,H_2O(l) + 3\,e^- \longrightarrow MnO_2(s) + 4\,OH^-(aq)$	+0.59
$HNO_2(aq) + H^+(aq) + e^- \longrightarrow NO(g) + H_2O(l)$	+1.00
$N_2(g) + 4\,H_2O(l) + 4\,e^- \longrightarrow 4\,OH^-(aq) + N_2H_4(aq)$	−1.16
$N_2(g) + 5\,H^+(aq) + 4\,e^- \longrightarrow N_2H_5^+(aq)$	−0.23
$NO_3^-(aq) + 4\,H^+(aq) + 3\,e^- \longrightarrow NO(g) + 2\,H_2O(l)$	+0.96
$Na^+(aq) + e^- \longrightarrow Na(s)$	−2.71
$Ni^{2+}(aq) + 2\,e^- \longrightarrow Ni(s)$	−0.28
$O_2(g) + 4\,H^+(aq) + 4\,e^- \longrightarrow 2\,H_2O(l)$	+1.23
$O_2(g) + 2\,H_2O(l) + 4\,e^- \longrightarrow 4\,OH^-(aq)$	+0.40
$O_2(g) + 2\,H^+(aq) + 2\,e^- \longrightarrow H_2O_2(aq)$	+0.68
$O_3(g) + 2\,H^+(aq) + 2\,e^- \longrightarrow O_2(g) + H_2O(l)$	+2.07
$Pb^{2+}(aq) + 2\,e^- \longrightarrow Pb(s)$	−0.126
$PbO_2(s) + HSO_4^-(aq) + 3\,H^+(aq) + 2\,e^- \longrightarrow PbSO_4(s) + 2\,H_2O(l)$	+1.685
$PbSO_4(s) + H^+(aq) + 2\,e^- \longrightarrow Pb(s) + HSO_4^-(aq)$	−0.356
$PtCl_4^{2-}(aq) + 2\,e^- \longrightarrow Pt(s) + 4\,Cl^-(aq)$	+0.73
$S(s) + 2\,H^+(aq) + 2\,e^- \longrightarrow H_2S(g)$	+0.141
$H_2SO_3(aq) + 4\,H^+(aq) + 4\,e^- \longrightarrow S(s) + 3\,H_2O(l)$	+0.45
$HSO_4^-(aq) + 3\,H^+(aq) + 2\,e^- \longrightarrow H_2SO_3(aq) + H_2O(l)$	+0.17
$Sn^{2+}(aq) + 2\,e^- \longrightarrow Sn(s)$	−0.136
$Sn^{4+}(aq) + 2\,e^- \longrightarrow Sn^{2+}(aq)$	+0.154
$VO_2^+(aq) + 2\,H^+(aq) + e^- \longrightarrow VO^{2+}(aq) + H_2O(l)$	+1.00
$Zn^{2+}(aq) + 2\,e^- \longrightarrow Zn(s)$	−0.763

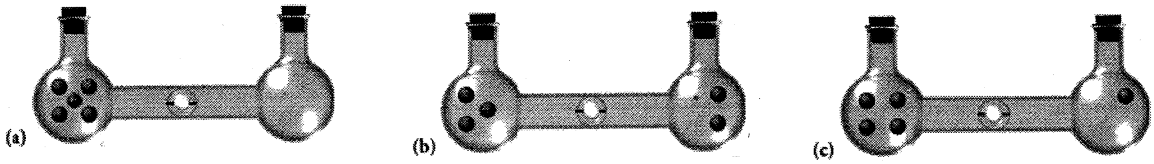
Equilibrium constants for of complex-ion formation reactions. Cations that form complex ions with OH^- and NH_3 are given for: Ag, Al, Bi, Co, Cr, Cu, Fe, Ni, Zn.

Formation reaction	K_f
$Ag^+ + 2\ Cl^- \rightleftharpoons AgCl_2^-$	1.8×10^5
$Ag^+ + 2\ NH_3 \rightleftharpoons Ag(NH_3)_2^+$	1.6×10^7
$Pb^{2+} + 3\ Cl^- \rightleftharpoons PbCl_3^-$	2.4×10^1
$Co^{2+} + 6\ NH_3 \rightleftharpoons Co(NH_3)_6^{2+}$	5.0×10^4
$Co^{3+} + 6\ NH_3 \rightleftharpoons Co(NH_3)_6^{3+}$	4.6×10^{33}
$Cr^{3+} + 6\ NH_3 \rightleftharpoons Cr(NH_3)_6^{3+}$	5.8×10^8
$Cu^{2+} + 4\ NH_3 \rightleftharpoons Cu(NH_3)_4^{2+}$	1.1×10^{13}
$Ni^{2+} + 6\ NH_3 \rightleftharpoons Ni(NH_3)_6^{2+}$	2.0×10^8
$Zn^{2+} + 4\ NH_3 \rightleftharpoons Zn(NH_3)_4^{2+}$	7.8×10^8
$Cu^{2+} + 4\ OH^- \rightleftharpoons Cu(OH)_4^{2-}$	1.3×10^{16}
$Zn^{2+} + 4\ OH^- \rightleftharpoons Zn(OH)_4^{2-}$	4.6×10^{17}
$Pb^{2+} + 3\ OH^- \rightleftharpoons Pb(OH)_3^-$	3.8×10^{14}
$Al^{3+} + 4\ OH^- \rightleftharpoons Al(OH)_4^-$	7.7×10^{33}
$Cr^{3+} + 4\ OH^- \rightleftharpoons Cr(OH)_4^-$	8×10^{29}





1. [7 Points] Rank the states below in order of increasing entropy.



   a. (a) < (c) < (b)
   b. (b) < (c) < (a)
   c. (c) < (b) < (a)
   d. (a) < (b) < (c)
   e. (c) < (a) < (b)

2. [7 points] Which change is likely to be accompanied by an increase in entropy?

   a. $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$ at 25°C
   b. $Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$ at 25°C
   c. $CO_2(s) \rightarrow CO_2(g)$ at –70°C
   d. $H_2O(g) \rightarrow H_2O(l)$ at 100°C
   e. Both (c) and (d)

3. [7 points] For the reaction:

$$2O(g) \rightarrow O_2(g)$$

   What are the signs of the enthalpy and entropy changes?

   a. Both are negative.
   b. The enthalpy change is negative, while the entropy change is positive.
   c. The enthalpy change is positive, while the entropy change is negative.
   d. Both are positive.
   e. Not enough information is given.

4. [7 Points] A reaction is spontaneous at all temperatures. The reaction is:

   a. exothermic and decreases the entropy of the system.
   b. exothermic and increases the entropy of the system.
   c. endothermic and decreases the entropy of the system.
   d. endothermic and increases the entropy of the system.
   e. no reactions are spontaneous at all temperatures.

5. [7 Points] Consider the reaction:

$$A(g) + 2B(g) \rightarrow C(l)$$

In order for this reaction to be spontaneous under standard conditions, the reaction must:

a. result in an increase of the entropy of the system.
b. take place in the presence of a catalyst.
c. be exothermic.
d. take place at high temperatures.
e. this reaction could not be spontaneous under standard conditions.

6. [7 Points] Suppose a scientist made a claim that all spontaneous reactions are exothermic. Which of the following would provide the strongest challenge to their claim?

a. An endothermic reaction that only proceeds when coupled to an exothermic reaction.
b. An endothermic reaction that only proceeds at a reasonable rate when a catalyst is present.
c. An endothermic reaction which is not spontaneous.
d. An exothermic reaction which is not spontaneous.
e. All of the above

7. [7 Points]For this reaction at 25°C, $\Delta H^\circ = -1854$ kJ and $\Delta S^\circ = -236\ J \cdot K^{-1}$

$$CH_3COCH_3(g) + 4O_2(g) \rightarrow 3CO_2(g) + 3H_2O(l)$$

What is the value for ΔG° for this reaction?

a. –1784 kJ
b. –1848 kJ
c. –1924 kJ
d. –2736 kJ
e. 68500 kJ

8. [7 Points] Below what temperature does the following reaction become nonspontaneous?

$2\ HNO_3(aq) + NO(g) \rightarrow 3\ NO_2(g) + H_2O(l)$; $\Delta H = +136.5$ kJ; $\Delta S = +287.5$ J/K

a. 475 K
b. 151 K
c. 39.2 K
d. This reaction is nonspontaneous at all temperatures.
e. This reaction is spontaneous at all temperatures.

9. [7 Points] Calculate ΔG_{rxn} at 298 K under the conditions shown below for the following reaction.

$$SO_3(g) + H_2O(g) \rightarrow H_2SO_4(l);\ \Delta G° = -90.5\ kJ$$

$$P_{SO_3} = 0.20\ atm,\ P_{H_2O} = 0.88\ atm$$

a. +15.9 kJ
b. +51.4 kJ
c. –90.5 kJ
d. –86.2 kJ
e. –30.4 kJ

10. [7 Points] Determine the equilibrium constant for the following reaction at 498 K.

$$2\ Hg(g) + O_2(g) \rightarrow 2\ HgO(s);\ \Delta H° = -304.2\ kJ;\ \Delta S° = -414.2\ J/K$$

a. 4.33×10^{21}
b. 8.10×10^{31}
c. 5.34×10^{-11}
d. 2.31×10^{-22}
e. 1.87×10^{10}

11. [7 points] Which of the following is true concerning oxidation and reduction half-reactions?

a. A reduction half reaction can occur by itself if the reduction half-reaction potential is applied across the reaction.
b. A reduction half reaction can occur by itself if the negative of the reduction half-reaction potential is applied across the reaction.
c. Oxidation and reduction must take place simultaneously.
d. Reduction can only occur by itself in the presence of a strong reducing agent.
e. Both (a) and (d)

12. [7 Points] A copper wire is placed in a solution of $AgNO_3$. Is there a reaction?

a. No, because silver ions cannot oxidize copper.
b. No, because silver ions cannot reduce copper.
c. No, because a salt bridge must be present.
d. Yes, because silver ions can reduce copper.
e. Yes, because silver ions can oxidize copper.

13. [7 points] Suppose an electrolytic cell utilizes the following half-reactions:

Anode:

$$Mg(s) \rightarrow Mg^{2+}(aq) + 2\ e^-$$

Cathode:

$$Cu^+(aq) + e^- \rightarrow Cu(s)$$

How many moles of magnesium need to be oxidized in order to reduce three moles of copper ions?

a. 2/3
b. 3/2
c. 2
d. 3
e. 6

14. [7 Points] What is the simplified balanced redox reaction for the reaction below occurring in basic solution.

$$CN^-(aq) + MnO_4^-(aq) \rightarrow CNO^-(aq) + MnO_2(s)$$

a. $6\ OH^-(aq) + 3CN^-(aq) + 4\ H_2O(l) + 2\ MnO_4^-(aq) \rightarrow 3CNO^-(aq) + 3H_2O(l) + 2\ MnO_2(s) + 8OH^-(aq)$
b. $3e^- + 2OH^-(aq) + CN^-(aq) + 2\ H_2O(l) + MnO_4^-(aq) \rightarrow CNO^-(aq) + H_2O(l) + MnO_2(s) + 8OH^-(aq) + 2e^-$
c. $3CN^-(aq) + H_2O(l) + 2\ MnO_4^-(aq) \rightarrow 3CNO^-(aq) + 2MnO_2(s) + 2OH^-(aq)$
d. $3CN^-(aq) + 2MnO_4^-(aq) \rightarrow 3CNO^-(aq) + 2MnO_2(s)$
e. none of the above

15. [7 Points] Consider an electrochemical cell that utilizes lithium and zinc:

$Li^+(aq) + e^- \rightarrow Li(s)$ $\quad E^\circ = -3.05$ V
$Zn^{2+}(aq) + 2e^- \rightarrow Zn(s)$ $\quad E^\circ = -0.76$ V

What is the standard voltage for this cell?

a. 0.00 V
b. 1.90 V
c. 2.29 V
d. 3.81 V
e. 5.34 V

16. [7 Points] Consider a cell making use of the following half-reactions:

Anode:

$$Mg(s) \rightarrow Mg^{2+}(aq) + 2\ e^-$$

Cathode:

$$MnO_2(s) + 4H^+(aq) + 2e^- \rightarrow Mn^{2+}(aq) + 2H_2O$$

Under standard conditions, this cell yields a potential of 3.6V. If the pH were then increased to 7 and the concentrations of the other ions maintained at 1 M, the cell potential would most likely:

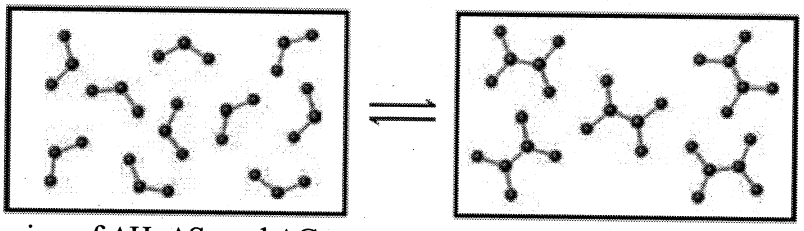
a. Decrease
b. Increase
c. Stay the same
d. Asymptotically approach 1 V
e. Would increase only if a strong acid is used

17. [7 Points] The standard potential of a galvanic cell is +2.03 V. Which of the following must be true of the cell?

I. $K > 1$
II. $\Delta S^\circ > 0$
III. $\Delta S^\circ < 0$

a. II only
b. I and II only
c. II and III only
d. I and III only
e. I, II, and III

18. [7 Points] In the Thermochemistry MC assignment, the image below represented a spontaneous, gaseous reaction at constant temperature.



Predict the sign of ΔH, ΔS, and ΔG.

a. $\Delta H = +, \Delta S = +, \Delta G = -$
b. $\Delta H = -, \Delta S = -, \Delta G = +$
c. $\Delta H = -, \Delta S = +, \Delta G = -$
d. $\Delta H = -, \Delta S = -, \Delta G = -$
e. $\Delta H = +, \Delta S = -, \Delta G = -$

19. Consider the decomposition of barium carbonate:

$$BaCO_3(s) \leftrightarrow BaO(s) + CO_2(g)$$

At 298 K, the equilibrium pressure of CO_2 was determined to be 6×10^{-39} atm and ΔH°=269.3 kJ, ΔS°= 171.92 J/K, and ΔG°= 218.1 kJ. What is the equilibrium pressure of CO_2 at 1450 K?

a. 1.4×10^{-8} atm
b. 0.19 atm
c. 0.98 atm
d. 1.0 atm
e. 5.2 atm

20. [7 Points] Consider the unbalanced hydrogenation reaction of acetylene:

$$C_2H_2(g) + H_2(g) \rightarrow C_2H_6(g)$$

Given the following data, what is the K_p for the reaction?

Substance	ΔG_f°(kJ/mol)
$C_2H_2(g)$	209.2
$H_2(g)$	0
$C_2H_6(g)$	–32.89

a. 3.6×10^{-43}
b. 0.90
c. 1.1
d. 2.7×10^{-42}
e. None of the above

21. [7 Points] Ag_2CrO_4 has a solubility in water, at 25°C, of 6.7×10^{-5} mol/L and its ΔH°= 51.8 kJ/mol. What is its solubility at 75.5°C?

a. 1.8×10^{-4}
b. 3.1×10^{-4}
c. 6.7×10^{-5}
d. 9.3×10^{-8}
e. 2.5×10^{-11}

22. [7 Points] For the reaction:

$$2\ Co^{3+}(aq) + 2Cl^{-}(aq) \rightarrow 2Co^{2+}(aq) + Cl_2(g) \qquad E^\circ = 0.71\ V$$

what is the cell potential at 25 °C if the concentrations are $[Co^{3+}] = 0.156$ M, $[Co^{2+}] = 0.624$ M, and $[Cl^{-}] = 0.723$ M and the pressure of Cl_2 is $P_{Cl_2} = 9.10$ atm?

a. $E_{cell} = 0.604$ V
b. $E_{cell} = 0.638$ V
c. $E_{cell} = 0.659$ V
d. $E_{cell} = 0.741$ V
e. $E_{cell} = 0.774$ V

23. [7 points] How many minutes will it take to electroplate 33.1 grams of chromium by running 5.00 amps of current through a solution of $Cr^{3+}(aq)$?

a. 204
b. 408
c. 614
d. 1.54×10^4
e. 3.69×10^4

24. [7 Points] Calculate the concentration of Cu^{2+} remaining in 455 mL of solution that was originally 0.350 M $CuSO_4$ after the passage of 4.57 amps for 3.50 minutes.

a. 0.0110 M
b. 0.0220 M
c. 0.328 M
d. 0.339 M
e. 0.349 M

25. [7 Points] The K_{sp} of $Ca(OH)_2$ is 6.5×10^{-6}. Find the E_{cell} for the following half reaction:

$$Ca(OH)_2(s) + 2e^{-} \leftrightarrow Ca(s) + 2\ OH^{-}(aq)$$

a. –2.81 V
b. –2.87 V
c. –2.93 V
d. –2.97 V
e. –3.06 V

Use this page for Scratch Paper

Use this page for Scratch paper