Exam Five	Academic Integrity Pledge:
Chm 205 (Dr. Mattson)	In keeping with Creighton University's ideals and with the Academic Integrity Code adopted by the College of Arts and Sciences, I pledge that this work is my own and that I
24 April 2009	have neither given nor received inappropriate assistance in preparing it.
	Signature

Instructions: Show all work whenever a calculation is required! You will receive credit for <u>how</u> you worked each problem as well as for the correct answer. If you need more space, you may use the back of your periodic table — Write: "See PT" in box and then attach the periodic table. BOX YOUR ANSWERS! Write legibly.

1. (5 pts) Balance the following redox reaction in acidic solution.

$$\operatorname{BrO}_4^- + \operatorname{NH}_4^+ \rightarrow \operatorname{Br}_2^- + \operatorname{NO}_2^-$$

2. Consider the following redox reaction:

$$Sn + 2 \operatorname{Ag}^+ \rightarrow Sn^{+2} + 2 \operatorname{Ag} \quad E^0 = +0.94 \operatorname{V}$$

2(a) (4 pts) Label the electrodes and solutions with the following labels: "Sn," "Sn⁺²," "Ag," and "Ag⁺." Assume that the anion in both cells and the salt bridge is nitrate. <u>Make the left cell the anode and the right cell the cathode.</u>



2(b) (3 pts) Indicate the direction of electron flow in the wire and of ion flow in the solution.

- 2(c) (2 pts) In which cell is the concentration of metal ions increasing? Circle: Anode or Cathode
- 2(d) (2 pts) In which cell is the mass of the electrode increasing? Circle: Anode or Cathode
- 2(e) (4 pts) Write the reaction using cell notation assuming all concentrations are 1.0 M

2(f) (2 pts) What is ΔG^{0} for this reaction?

- A. $\Delta G^{o} > 0$ B. $\Delta G^{o} = 0$
- C. $\Delta G^{0} < 0$ D. cannot predict

2(g) (2 pts) What is the value for n in this reaction?

A. one B. two C. three D. four

3. Given these two reduction half reactions:

Ni⁺² + 2 e⁻ → Ni $E^{0} = -0.26 V$ Co⁺² + 2 e⁻ → Co $E^{0} = -0.28 V$

3(a) (2 pts) Which is the most easily reduced?

A. Ni^{+2} B. Ni C. Co^{+2} D. Co

3(b) (2 pts) Which is the most easily oxidized?

A. Ni⁺² B. Ni C. Co⁺² D. Co

3(c) (4 pts) Write this as a balanced redox reaction:

Co | Co⁺² (1.0 M) | | Ni⁺² (1.0 M) | Ni

3(d) (4 pts) What is E^o for this reaction?

3(e) (4 pts) What is K_c for this reaction?

3(f) (4 pts) What is ΔG^0 , in kJ, for this reaction?

3(g) (5 pts) Use the Nernst equation to calculate E if $[Co^{+2}] = 0.040$ M and $[Ni^{+2}] = 1.0$ M

4. (5 pts) How long would it take, in seconds, to electroplate 0.10 mol gold from a solution of Au⁺³ using a current of 50 amps?

5(a) (2 pts) Write the electron configuration for Co^{+2} .

5(b) (2 pts) What +3 ion has electron configuration [Ar] $4s^0 3d^3$?

6. (4 pts) Which ion is the smallest ion in each set?

(a) Cr^{+2} Cr^{+3} Cr^{+6} (b) Fe^{+2} Co^{+2} Ni^{+2}

7(a) (3 pts) Sketch the *cis* isomer of $Mn(Cl)_2(Br)_4^{-2}$.



7(b) (3 pts) Sketch the *fac* isomer of $Mn(Cl)_3(Br)_3^{-4}$.



8. (4 pts) Carbon monoxide has the Lewis dot structure :C:::O: and is known to function as a ligand. Use formal charges to determine if the carbon or the oxygen end of the molecule donates the electron pair to the metal cation.

Conclusion:	donates an E group to metal.

9. (9 pts) Use Lewis dot structures to predict whether or not these could serve as ligands

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PH_3	SiH_4	SH_2	
Ligand? Yes No	Ligand? Yes No	Ligand? Yes No	

10. (6 pts) Determine the oxidation state on the metal atom in each of these complexes.

 $Co(NH_3)_4(Br)_2$

K₃[Fe(CN)₆]

 $[Cr(NH_3)_6]SO_4$

- (2 pts) Is [Cr(NH₃)₆]SO₄diamagnetic or paramagnetic? Circle: diamagnetic paramagnetic
- 12. (2 pts) Ethylene diamine has the formula NH₂CH₂CH₂NH₂. This ligand
 - A. connects two metal cations together.
 - B. only coordinates in a trans arrangement.
 - C. is a bidentate chelate.
 - D. is associated with tetrahedral geometries.
- 13. (3 pts) Match description and picture
 - _____ The orbital called $d_x 2_{-v} 2$
 - _____ The orbital called d_z2

____ One of three similar orbitals including d_{vz}



14. (4 pts) Write balanced nuclear equations for the following processes:

14(a) α-emission of	
$^{210}_{85}At$	
14(b) β-emission of	

 $^{199}_{79}Au$

15. (3 pts) The half life of indium-111, a radioactive isotope used in studying the distribution of white blood cells, is t $_{1/2}$ = 2.805 days. Approximately what percent of the isotope remains after 6 days?

(a) 10% (b) 20% (c) 33% (d) 50% (e) >50%

Print your name in the box.

Name: (only if you answer yes below):

Work to be graded on this sheet?

YES: If you have done work to be graded on this sheet, you must submit it with your exam and include your name above. Do not clip it to the exam — simply hand them in together.

NO: If there is nothing to grade on this sheet, simply return it to the pile next to the exams.

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39.10 37	40.08 38	5C 44.96 39	47.90 40	V 50.94 41	52.00 42	MN 54.94 43	⊢ e 55.85 44	58.93 45	NI 58.70 46	63.55 47	Zn 65.38 48	Ga 69.72 49	Ge 72.59 50	AS 74.92 51	5e _{78.96} 52	Br 79.90 53	КГ 83.80 54
39.10 37 Rb	Ca 40.08 38 Sr	5C 44.96 39 Y	47.90 40 Zr	V 50.94 41 Nb	Cr 52.00 42 Mo	Mn 54.94 43 TC	Fe 55.85 44 Ru	CO 58.93 45 Rh	NI 58.70 46 Pd	CU 63.55 47 Ag	2n 65.38 48 Cd	Ga 69.72 49 In	Ge 72.59 50 Sn	AS 74.92 51 Sb	5e 78.96 52 Te	Br _{79.90} 53 	κς 83.80 54 Χε
к 39.10 37 Rb 85.47	Ca 40.08 38 Sr 87.62	5C 44.96 39 Y 88.91	47.90 40 Zr 91.22	V 50.94 41 Nb 92.91	42 Mo 95.94	Mn 54.94 43 Tc 97	Fe 55.85 44 Ru 101.07	CO 58.93 45 Rh 102.91	NI 58.70 46 Pd 106.4	63.55 47 Ag 107.87	2n 65.38 48 Cd 112.41	Ga 69.72 49 In 114.82	Ge 72.59 50 Sn 118.69	AS 74.92 51 Sb 121.75	5e 78.96 52 Te 127.60	Br 79.90 53 I 126.90	K r 83.80 54 X e 131.30
K 39.10 37 Rb 85.47 55	Ca 40.08 38 Sr 87.62 56	5C 44.96 39 Y 88.91 57	47.90 40 Zr 91.22 72	V 50.94 41 Nb 92.91 73	Cr 52.00 42 Mo 95.94 74	Mn 54.94 43 Tc 97 75	Fe 55.85 44 Ru 101.07 76	CO 58.93 45 Rh 102.91 77	NI 58.70 46 Pd 106.4 78	CU 63.55 47 Ag 107.87 79	2 n 65.38 48 Cd 112.41 80	Ga 69.72 49 In 114.82 81	Ge 72.59 50 Sn 118.69 82	AS 74.92 51 Sb 121.75 83	Se 78.96 52 Te 127.60 84	Br 79.90 53 l 126.90 85	K r 83.80 54 X e 131.30 86
к 39.10 37 Rb 85.47 55 С.5	Ca 40.08 38 Sr 87.62 56 Ba	5C 44.96 39 Y 88.91 57	11 47.90 40 Zr 91.22 72 Hf	V 50.94 41 Nb 92.91 73 Ta	Cr 52.00 42 Mo 95.94 74 W	Mn 54.94 43 TC 97 75 Re	Fe 55.85 44 Ru 101.07 76 Os	CO 58.93 45 Rh 102.91 77 Ir	NI 58.70 46 Pd 106.4 78 Pt	CU 63.55 47 Ag 107.87 79 Au	2n 65.38 48 Cd 112.41 80 Ha	Ga 69.72 49 In 114.82 81 Ti	Ge 72.59 50 Sn 118.69 82 Pb	AS 74.92 51 Sb 121.75 83 Bi	Se 78.96 52 Te 127.60 84 Po	Br 79.90 53 I 126.90 85 At	Kr 83.80 54 Xe 131.30 86 Rn
K 39.10 37 Rb 85.47 55 Cs 132.91	Ca 40.08 38 Sr 87.62 56 Ba 137.33	SC 44.96 39 Y 88.91 57 La 138.91	11 47.90 40 Zr 91.22 72 Hf 178,49	V 50.94 41 Nb 92.91 73 Ta 180.95	Cr 52.00 42 Mo 95.94 74 W 183.85	Mn 54.94 43 Tc 97 75 Re 186,21	Fe 55.85 44 Ru 101.07 76 Os 190.2	CO 58.93 45 Rh 102.91 77 Ir 192.22	NI 58.70 46 Pd 106.4 78 Pt 195.09	CU 63.55 47 Ag 107.87 79 Au 196.97	2n 65.38 48 Cd 112.41 80 Hg 200.59	Ga 69.72 49 In 114.82 81 Ti 204.37	Ge 72.59 50 Sn 118.69 82 Pb 207.2	AS 74.92 51 Sb 121.75 83 Bi 208.98	Se 78.96 52 Te 127.60 84 Po 209	Br 79.90 53 I 126.90 85 At 210	Kr 83.80 54 Xe 131.30 86 Rn 222
K 39.10 37 Rb 85.47 55 Cs 132.91 87	Ca 40.08 38 Sr 87.62 56 Ba 137.33 88	SC 44.96 39 Y 88.91 57 La 138.91 89	11 47.90 40 Zr 91.22 72 Hf 178.49	V 50.94 41 Nb 92.91 73 Ta 180.95	Cr 52.00 42 Mo 95.94 74 W 183.85	Mn 54.94 43 Tc 97 75 Re 186.21	F e 55.85 44 Ru 101.07 76 Os 190.2	CO 58.93 45 Rh 102.91 77 Ir 192.22	NI 58.70 46 Pd 106.4 78 Pt 195.09	Cu 63.55 47 Ag 107.87 79 Au 196.97	2n 65.38 48 Cd 112.41 80 Hg 200.59	Ga 69.72 49 In 114.82 81 Ti 204.37	Ge 72.59 50 Sn 118.69 82 Pb 207.2	AS 74.92 51 Sb 121.75 83 Bi 208.98	Se 78.96 52 Te 127.60 84 Po 209	Br 79.90 53 I 126.90 85 At 210	Kr 83.80 54 Xe 131.30 86 Rn 222
K 39.10 37 Rb 85.47 55 Cs 132.91 87 Er	Ca 40.08 38 Sr 87.62 56 Ba 137.33 88 Pa	SC 44.96 39 Y 88.91 57 La 138.91 89 ▲ C	11 47.90 40 Zr 91.22 72 Hf 178.49	V 50.94 41 Nb 92.91 73 Ta 180.95	Cr 52.00 42 Mo 95.94 74 W 183.85	Mn 54.94 43 Tc 97 75 Re 186.21	F e 55.85 44 Ru 101.07 76 Os 190.2	CO 58.93 45 Rh 102.91 77 Ir 192.22	NI 58.70 46 Pd 106.4 78 Pt 195.09	CU 63.55 47 Ag 107.87 79 Au 196.97	2n 65.38 48 Cd 112.41 80 Hg 200.59	Ga 69.72 49 In 114.82 81 Ti 204.37	Ge 72.59 50 Sn 118.69 82 Pb 207.2	As 74.92 51 Sb 121.75 83 Bi 208.98	Se 78.96 52 Te 127.60 84 Po 209	Br 79.90 53 I 126.90 85 At 210	Kr 83.80 54 Xe 131.30 86 Rn 222
K 39.10 37 Rb 85.47 55 Cs 132.91 87 Fr 200	Ca 40.08 38 Sr 87.62 56 Ba 137.33 88 Ra	SC 44.96 39 Y 88.91 57 La 138.91 89 AC	 47.90 40 Zr 91.22 72 Hf 178.49	V 50.94 41 Nb 92.91 73 Ta 180.95	Cr 52.00 42 Mo 95.94 74 W 183.85	Mn 54.94 43 Tc 97 75 Re 186.21	F e 55.85 44 Ru 101.07 76 Os 190.2	CO 58.93 45 Rh 102.91 77 Ir 192.22	NI 58.70 46 Pd 106.4 78 Pt 195.09	Cu 63.55 47 Ag 107.87 79 Au 196.97	2n 65.38 48 Cd 112.41 80 Hg 200.59	Ga 69.72 49 In 114.82 81 Ti 204.37	Ge 72.59 50 Sn 118.69 82 Pb 207.2	AS 74.92 51 Sb 121.75 83 Bi 208.98	Se 78.96 52 Te 127.60 84 PO 209	Br 79.90 53 I 126.90 85 At 210	Kr 83.80 54 Xe 131.30 86 Rn 222

Useful equations:

$$E = E^o - \frac{0.0592}{n} \log Q$$

$$E^o = \frac{0.0592}{n} \log K$$

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

- F = 96500 C / mol = 96500 J / mol V
- $Charge(coul) = Current(amps) \times time(s)$

 $1 faraday = 1 mol e^- = 96500 coul$

Answers:

1. 2 BrO_4^- + 2 NH_4^+ \rightarrow Br_2 + 2 NO_2^- + 4 H_2^- O

2(a) Left beaker should be labeled: "Sn," and "Sn $^{+2}$ " The beaker on the right labeled "Ag" and "Ag $^{+}$ "

2(b) Electrons are flowing left to right through the wire and anions are flowing right to left through salt bridge.

- 2(c) Anode
- 2(d) Cathode
- 2(e) $Sn | Sn^{+2}(1 M) | | Ag^{+}(1 M) | Ag^{"}$
- 2(f) $\Delta G^0 < 0$
- 2(g) two
- 3(a) Ni⁺²
- 3(b) Co
- $3(c) \operatorname{Ni}^{+2} + \operatorname{Co} \rightarrow \operatorname{Ni}^{+2} + \operatorname{Co}^{+2}$
- 3(d) E^o +0.02 v
- $3(e) \text{ K}_{c} = 4.74$
- $3(f) \Delta G^{0} = -3.86 \text{ kJ}$
- 3(g) E = 0.06 v
- $4.\ 579\ s$
- $5(a) [Ar] 4s^0 3d^7$
- 5(b) Cr³⁺
- 6. (a) Cr^{+6} (b) Ni^{+2}
- 7(a) two chlorides 90 degrees apart
- 7(b) three chlorides 90 degrees apart
- 8. The carbon has a formal charge = -1 and oxygen +1. Donates through electron-rich carbon.
- 9. (a) PH_3 is AB_3E , therefore a ligand (b SiH_4 is AB_4 , therefore not a ligand (c) PH_3 is AB_2E_2 , therefore a ligand
- 10. +2, +3, +2
- 11. paramagnetic
- 12. C
- 13. A, C, B
- 14. (a) ${}^{210}_{85}At \rightarrow {}^{4}_{2}\alpha + {}^{206}_{83}Bi$ (b) ${}^{199}_{79}Au \rightarrow {}^{0}_{-1}\beta + {}^{199}_{80}Hg$
- 15. (b) 20%