Exam Five **CHM 205 (Dr. Mattson)** **20 APRIL 2007**	***Academic Integrity Pledge:*** *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 have neither given nor received inappropriate assistance in preparing it.* *Signature:*

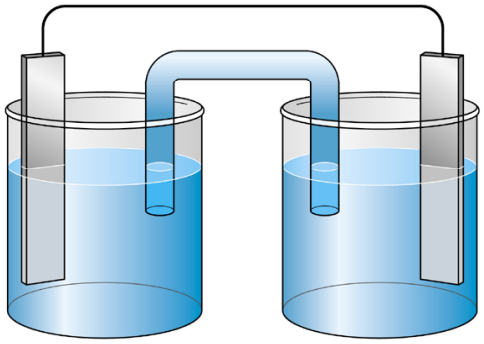
Instructions: Show all work whenever a calculation is required! You will receive credit for how you worked each problem as well as for the correct answer. This exam is worth 100 points. BOX YOUR ANSWERS!

Chapter 18. Electrochemistry

1. Consider the galvanic reaction between the two half cells, Pb | Pb^{+2}(aq) and Ag | Ag^{+}(aq).

1(a) (6 pts) Determine the spontaneous reaction. Write a balanced overall equation *and* determine E^o.

1(b) (4 pts) Label the electrodes and solutions with the following labels: "Pb," "Pb^{+2}," "Ag," and "Ag^{+}." *Make the left cell the anode and the right cell the cathode.*



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

1(d) (2 pts) In which cell is the concentration of ions increasing? Circle: Left or Right

1(e) (2 pts) In which cell is the mass of the electrode increasing? Circle: Left or Right

1(f) (3 pts) When will the cell voltage go to zero?

2. (a) (3 pts) Write a balanced equation for the following galvanic cell and (b) determine E^o (you must write the half rxns)

Cr(s) | Cr^{+3}aq) | | Ag^{+}(aq) | Ag(s)

3. (4 pts) Consider the galvanic cell:

Zn(s) | Zn^{+2}(aq) | | Eu^{+3}(aq) | Eu^{+2}(aq) | Pt(s) E^o = +0.40 V

Determine the standard reduction potential for the Eu^{+3}(aq) | Eu^{+2}(aq) half cell.

4. Consider the galvanic cell:

Ni(s) | Ni^{+2}(aq) | | Sn^{+2}(aq) | Sn(s) E^o = +0.12 V

(a) (4 pts) Determine the equilibrium constant, K?

(b) (4 pts) What is the value of ΔG^o?

5. (4 pts) Consider a galvanic cell that uses the reaction:

$2Ag^{+}(aq) + Sn(s) \rightarrow 2\ Ag(s) + Sn^{+2}(aq)$ E^o = +0.94 V

Calculate the potential at 25 ^oC for a cell that has $[Ag^{+}]$ = 0.040 M and $[Sn^{+2}]$ = 0.010 M

6. (4 pts) What mass of cobalt can be obtained from an aqueous solution of cobalt(II) nitrate if the solution is electrolyzed for 20.0 min with a current of 2.40 A?

7 (4 pts) Balance this reaction in acidic solution.

$PbO_2(s) + Mn^{+2}(aq) \rightarrow Pb^{+2}(aq) + MnO_4^-$

8. (12 pts) Complete the table.

	Electron configuration (use core notation)	Number unpaired electrons	Dia- or para-magnetic?
Co^{+2}			*Dia Para*
Mo^{+3}			*Dia Para*
Mn^{+2}			*Dia Para*
Zn^{+2}			*Dia Para*

9. (6 pts) Use Lewis dot structures to determine which of these could be ligands: Circle Yes or No

NH_4^+ Yes No	OH^- Yes No	PH_3 Yes No

10. (6 pts) Determine the oxidation state of the metal ion in each of these complexes. Box your answers!

$K_4[Fe(CN)_6]$
$Cr(NH_3)_3Cl_3$
$[Co(NH_3)_5Br]SO_4$

11. (6 pts) What is the coordination number and geometry name for each of these complexes?

$[Co(en)_2(H_2O)Br]^{+2}$
$Cr(NH_3)_3Cl_3$
$K_2[Co(SCN)_4]$

12. (4 pts) Which complexes can exist as diastereomers?

(a) $[Cr(NH_3)_2Cl_4]^-$	Circle Yes or No
(b) $[Co(NH_3)_5Br]^{+2}$	Circle Yes or No
(c) $[FeCl_2(NCS)_2]^{-2}$ (tetrahedral)	Circle Yes or No
(d) $[PtCl_2Br_2]^{-2}$ (square planar)	Circle Yes or No

13. (8 pts) Write balanced nuclear equations for the following processes:

(a) α-emission of

$^{162}_{75}\mathrm{Re}$

(b) electron capture (K capture) of

$^{138}_{62}Sm$

(c) β-emission of

$^{188}_{74}W$

(d) positron emission of

$^{165}_{73}Ta$

14. (4 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 one week? Box your answer. Circle the approximate percent of the isotope that has decayed after one week.

(a) 0% (b) 20% (c) 33% (d) 50%

(e) 67% (f) 80% (g) 100%

15. (4 pts) How old is a sample of wood whose C-14 content is found to be 43% that of a living tree? The half-life of 14C is 5730 years..

☐ *Check here if you wish to receive practice problems as a series of pdf files via e-mail in order to prepare for the final exam. There will be three files covering the first semester and three covering the second. In all, there are 28 pages.*

Sign the Academic Integrity pledge (on the front) *and* print your name here:

Your exam score (100 possible): _____

Determine your grade:

A+ ≥ 95; A ≥ 90; B+ ≥ 85; B ≥ 80; C+ ≥ 75; C ≥ 70; D ≥ 60

	E^o (V)
$Ag^+ + e^- \longrightarrow Ag$	+0.80
$Fe^{+3} + e^- \longrightarrow Fe^{+2}$	+0.77
$I_2(s) + 2\ e^- \longrightarrow 2\ I^-$	+0.54
$Cu^{+2} + 2\ e^- \longrightarrow Cu$	+0.34
$Pb^{+2} + 2\ e^- \longrightarrow Pb$	-0.13
$Fe^{+2} + 2\ e^- \longrightarrow Fe$	-0.44
$Cr^{+3} + 3\ e^- \longrightarrow Cr$	-0.73
$Zn^{+2} + 2\ e^- \longrightarrow Zn$	-0.76
$Mg^{+2} + 2\ e^- \longrightarrow Mg$	-1.66

Useful equations

$\Delta G = \Delta H - T\Delta S$

$\Delta G^o = \Delta H^o - T\Delta S^o$

$\Delta G = \Delta G^o + RT\ln Q$

$\Delta G^o = -RT\ln K$

$\Delta G = -nFE$

$\Delta G^o = -nFE^o$

R = 8.314 J/mol K = 0.0821 L atm/mol K

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

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

Charge(coulombs) = Current(amps) x Time(s)

F = 96500 J/mol e^- V

F = 1 mol e^- = 96,500 coul

$$\ln\left(\frac{N_0}{N_t}\right) = kt$$

$$t_{1/2} = \frac{0.693}{k}$$

Answers:

Chapter 18. Electrochemistry

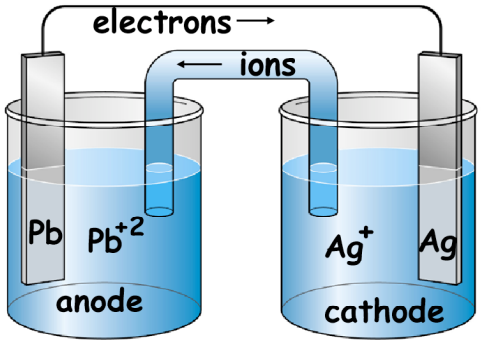
1(a)

$Pb(s) \rightarrow Pb^{+2}(aq) + 2\ e^-$ $E^o = +0.13$ V

$2\ Ag^+(aq) + 2\ e^- \rightarrow 2\ Ag(s)$ $E^o = +0.80$ V

$Pb(s) + 2\ Ag^+(aq) \rightarrow Pb^{+2}(aq) + 2\ Ag(s)$ $E^o = +0.93$ V

1(b) and (c)



1(d) Left; 1(e) Right

1(f) When the cell is at equilibrium or when the Pb electrode runs out or the silver(I) ion is depleted.

2.

$Cr(s) \rightarrow Cr^{+3}(aq) + 3\ e^-$ $E^o = +0.73$ V

$3\ Ag^+(aq) + 3\ e^- \rightarrow 3\ Ag(s)$ $E^o = +0.80$ V

$Cr(s) + 3\ Ag^+(aq) \rightarrow Cr^{+3}(aq) + 3\ Ag(s)$ $E^o = +1.53$ V

3. $E^o = -0.36$ V

4. (a) $K = 1.1 \times 10^{+4}$; (b) $\Delta G^o = -23.2$ kJ

5. E = +0.92 V

6. 0.879 g

7 $5\ PbO_2(s) + 2\ Mn^{+2}(aq) + 4\ H^+(aq) \rightarrow 5\ Pb^{+2}(aq) + 2\ MnO_4^- + 2\ H_2O(l)$

8.

	Electron configuration (use core notation)	Number unpaired electrons	Dia- or para-magnetic?
Co^{+2}	[Ar] $4s^0\ 3d^7$	3	*Para*
Mo^{+3}	[Ar] $5s^0\ 4d^3$	3	*Para*
Mn^{+2}	[Ar] $4s^0\ 3d^5$	5	*Para*
Zn^{+2}	[Ar] $4s^0\ 3d^{10}$	0	*Dia*

9.

NH_4^+ No AB_4	OH^- Yes ABE_3	PH_3 Yes AB_3E

10. Fe^{+2}; Cr^{+3}; Co^{+3}

11. C.N. = 6 (octahedral); C.N. = 6 (octahedral); C.N. = 4 (tetrahedral)

12. (a) yes; (b) no; (c) no; (d) yes

13.

(a) α-emission of

$$^{162}_{75}\mathrm{Re} \rightarrow ^{4}_{2}\alpha + ^{158}_{73}Ta$$

(b) electron capture (K capture) of

$$^{138}_{62}Sm + ^{0}_{-1}e \rightarrow ^{138}_{61}Pm$$

(c) β-emission of

$$^{188}_{74}W \rightarrow ^{0}_{-1}\beta + ^{188}_{75}\mathrm{Re}$$

(d) positron emission of

$$^{165}_{73}Ta \rightarrow ^{0}_{+1}\beta + ^{165}_{72}Hf$$

14. Box: (b) 20% Circle: (f) 80%

15. 6970 years