

EXAM FIVE
CHM 205 (Dr. Mattson)
18 APRIL 2008

Academic Integrity Pledge:

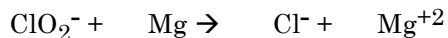
In keeping with Creighton University's ideals and with the Academic Integrity Code adopted by the College of Arts and Sciences, I pledge that this work is my own and that I have neither given nor received inappropriate assistance in preparing it.

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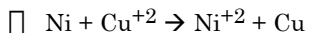
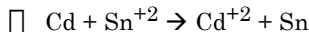
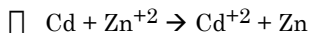
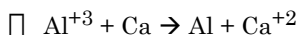
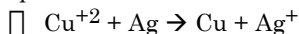
Instructions: Show all work whenever a calculation is required! You will receive credit for how you worked each problem as well as for the correct answer. If you need more space, you may use the back of your periodic table — Write: "See PT" in box and then attach the periodic table. **BOX YOUR ANSWERS!**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

Chapter 17. Electrochemistry

1 (4 pts) Balance this reaction in acidic solution.



2. (5 pts) Check these reactions (unbalanced) if they are spontaneous under standard conditions (> 1 possible):



3. Consider the galvanic reaction between the two half cells, $\text{Zn} | \text{Zn}^{+2}(\text{aq})$ and $\text{Sn} | \text{Sn}^{+2}(\text{aq})$.

3(a) (5 pts) Determine the spontaneous reaction. Write a balanced overall equation and determine E° .

3(b) (4 pts) Write the Galvanic cell using cell notation.

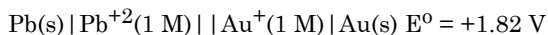
3(c) (2 pts) Which electrode is gaining mass? Zn or Sn

3(d) (2 pts) The cathode cell is: $\text{Zn} | \text{Zn}^{+2}$ or $\text{Sn} | \text{Sn}^{+2}$

3(e) (2 pts) What is the reducing agent?

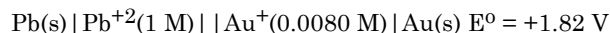
- (a) Zn (b) Zn^{+2} (c) Sn (d) Sn^{+2}

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

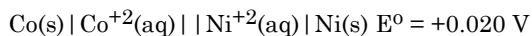


Determine the standard reduction potential for $\text{Au}^{+}(\text{aq}) + \text{e}^- \rightarrow \text{Au}(\text{s})$ half cell.

4(b) (5 pts) Determine E for:



5. Consider the galvanic cell:



5(a) (5 pts) Determine the equilibrium constant, K_c ?

5(b) (5 pts) What is the value of ΔG° ?

6. (5 pts) What mass of rhodium (MM = 102.9 g/mol) can be obtained from an aqueous solution of rhodium(III) nitrate if the solution is electrolyzed for 15.0 min with a current of 22.0 A?

Chapter 20. Transition Metals

7. (8 pts) Sketch Lewis dot diagrams in order to determine which of these are Lewis bases. Check those that are.

<input type="checkbox"/> CH ₄	<input type="checkbox"/> SH ₂
<input type="checkbox"/> CO ₂	<input type="checkbox"/> NH ₃

8. (2 pt) Transition metal cations are:
 (a) Lewis bases (b) Lewis acids (c) neither

- 9(a) (2 pts) Write the electron configuration for V⁺³.

[Ar]

- 9(b) (2 pts) How many unpaired electrons are in V⁺³?

- 9(c) (2 pts) Is V⁺³ paramagnetic? **Yes** or **No**

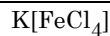
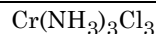
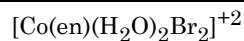
10. (5 pts) Consider the following periodic trends as they apply to the transition metals in order to answer these questions.

- (a) Which element is smallest? Cr Fe Cu
- (b) Which is largest? Fe Fe⁺² Fe⁺³
- (c) Which has smallest 1st ionization energy?
Sc Mn Cu
- (d) Which has largest density? V Mn Cu
- (e) Which has largest effective nuclear charge?
Ti Fe Cu

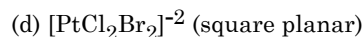
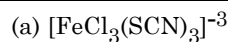
11. (6 pts) Determine the oxidation state of the metal ion in each of these complexes. Box your answers!

K ₂ [Ru(CN) ₆]
Cr(NH ₃) ₃ Cl ₃
K[Ti(NH ₃) ₃ Br ₃]

12. (6 pts) What is the coordination number and geometry name for each of these complexes? (“en” is the bidentate chelate NH₂CH₂CH₂NH₂)



13. (4 pts) How many isomers are possible for each of these complexes?



Chapter 22. Nuclear Chemistry

14. (6 pts) Write balanced nuclear equations for the following processes:

- (a) α-emission of



- (b) β-emission of



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 three days?

- (a) <10% (b) 10-25% (c) 25-50% (d) 50-75% (e) >75%

16. (5 pts) How old is a clam shell (mostly calcium carbonate) whose C-14 content is found to be 89% that of a live clam? The half-life of ¹⁴C is 5730 years.

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

**Standard Table of Reduction
Potentials**

	E° (V)
$\text{Cl}_2 + 2 \text{e}^- \rightarrow 2\text{Cl}^-$	1.36
$\text{O}_2 + 4 \text{H}^+ + 4 \text{e}^- \rightarrow 2 \text{H}_2\text{O}$	1.23
$\text{Br}_2 + 2 \text{e}^- \rightarrow 2 \text{Br}^-$	1.09
$\text{Ag}^+ + \text{e}^- \rightarrow \text{Ag}$	0.80
$\text{Fe}^{3+} + \text{e}^- \rightarrow \text{Fe}^{2+}$	0.77
$\text{I}_2 + 2 \text{e}^- \rightarrow 2 \text{I}^-$	0.54
$\text{O}_2 + 2 \text{H}_2\text{O} + 4 \text{e}^- \rightarrow 4 \text{OH}^-$	0.40
$\text{Cu}^{2+} + 2 \text{e}^- \rightarrow \text{Cu}$	0.34
$2 \text{H}^+ + 2 \text{e}^- \rightarrow \text{H}_2$	0.00
$\text{Fe}^{3+} + 3 \text{e}^- \rightarrow \text{Fe}$	-0.036
$\text{Pb}^{2+} + 2 \text{e}^- \rightarrow \text{Pb}$	-0.13
$\text{Sn}^{2+} + 2 \text{e}^- \rightarrow \text{Sn}$	-0.14
$\text{Ni}^{2+} + 2 \text{e}^- \rightarrow \text{Ni}$	-0.26
$\text{Co}^{2+} + 2 \text{e}^- \rightarrow \text{Co}$	-0.28
$\text{Cd}^{2+} + 2 \text{e}^- \rightarrow \text{Cd}$	-0.40
$\text{Fe}^{2+} + 2 \text{e}^- \rightarrow \text{Fe}$	-0.44
$\text{Cr}^{3+} + \text{e}^- \rightarrow \text{Cr}^{2+}$	-0.50
$\text{Cr}^{3+} + 3 \text{e}^- \rightarrow \text{Cr}$	-0.73
$\text{Zn}^{2+} + 2 \text{e}^- \rightarrow \text{Zn}$	-0.76
$2 \text{H}_2\text{O} + 2 \text{e}^- \rightarrow \text{H}_2 + 2\text{OH}^-$	-0.83
$\text{Mn}^{2+} + 2 \text{e}^- \rightarrow \text{Mn}$	-1.18
$\text{Al}^{3+} + 3 \text{e}^- \rightarrow \text{Al}$	-1.66
$\text{Mg}^{2+} + 2 \text{e}^- \rightarrow \text{Mg}$	-1.66
$\text{Na}^+ + \text{e}^- \rightarrow \text{Na}$	-2.71
$\text{Ca}^{2+} + 2 \text{e}^- \rightarrow \text{Ca}$	-2.76
$\text{K}^+ + \text{e}^- \rightarrow \text{K}$	-2.92
$\text{Li}^+ + \text{e}^- \rightarrow \text{Li}$	-3.05

Useful equations:

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

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

$$\Delta G = -nFE$$

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

$$F = 96500 \text{ C/mol}$$

$$\text{Charge(coul)} = \text{Current(amps)} \times \text{time(s)}$$

$$1 \text{ faraday} = 1 \text{ mol } \text{e}^- = 96500 \text{ coul}$$

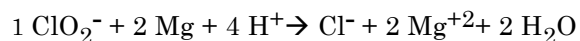
$$\ln \frac{N_0}{N_t} = kt$$

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

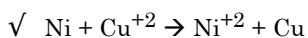
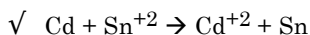
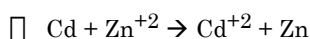
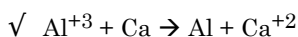
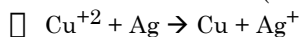
1 H																	2 He
3 Li	4 Be											5 B	6 C	7 N	8 O	9 F	10 Ne
11 Na	12 Mg											13 Al	14 Si	15 P	16 S	17 Cl	18 Ar
19 K	20 Ca	21 Sc	22 Ti	23 V	24 Cr	25 Mn	26 Fe	27 Co	28 Ni	29 Cu	30 Zn	31 Ga	32 Ge	33 As	34 Se	35 Br	36 Kr
37 Rb	38 Sr	39 Y	40 Zr	41 Nb	42 Mo	43 Tc	44 Ru	45 Rh	46 Pd	47 Ag	48 Cd	49 In	50 Sn	51 Sb	52 Te	53 I	54 Xe
55 Cs	56 Ba	57 La	72 Hf	73 Ta	74 W	75 Re	76 Os	77 Ir	78 Pt	79 Au	80 Hg	81 Tl	82 Pb	83 Bi	84 Po	85 At	86 Rn
87 Fr	88 Ra	89 Ac	104 Rf	105 Db	106 Sg	107 Bh	108 Hs	109 Mt		111	112		114		116		118

58 Ce	59 Pr	60 Nd	61 Pm	62 Sm	63 Eu	64 Gd	65 Tb	66 Dy	67 Ho	68 Er	69 Tm	70 Yb	71 Lu
90 Th	91 Pa	92 U	93 Np	94 Pu	95 Am	96 Cm	97 Bk	98 Cf	99 Es	100 Fm	101 Md	102 No	103 Lr

Answers:



2. Check these reactions (unbalanced) if they are spontaneous under standard conditions (> 1 possible):



3. (a) $E^0 = 0.62 \text{ v}$ (b) $\text{Zn} | \text{Zn}^{+2} || \text{Sn}^{+2} | \text{Sn}$ (c) Sn (d) $\text{Sn} | \text{Sn}^{+2}$ (e) Zn

4(a) $E^0 = +1.69 \text{ V}$ (b) $E^0 = +1.70 \text{ V}$

5(a) Determine the equilibrium constant, $K_c = 4.74$ (b) $\Delta G^0 = -3.86 \text{ kJ}$

6. 7.04 g Rh

7. CH_4 : AB_4 (not a ligand) SH_2 : AB_2E_2 (a ligand) CO_2 : AB_2 on central atom (not a ligand) NH_3 : AB_3E (a ligand)

8. (b)

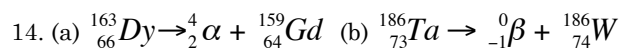
9(a) $\text{V}^{+3} 4s^0 3d^2$ (b) two unpaired electrons (c) Yes

10. (a) Cu (b) Fe (c) Sc (d) Cu (e) Cu

11. +4, +3, +2

12. Coord. Number = 6, octahedral; Coord. Number = 6, octahedral; Coord. Number = 4, tetrahedral

13. 2, 2, 1, 2



15. (c)

16. 960 years