Chemistry 223 Exam II Cover Sheet

Spring XXXX

Name: _____

This exam consists of twenty-five (25) multiple-choice questions and four (4) short answer questions with five points of extra credit.

A periodic table and scratch paper are available for you to use on this exam.

Before you start:

- Write your first and last name in the space above
- Sign the integrity statement below. **Failing to sign the integrity statement on this exam imparts an immediate grade of zero.**
- For multiple choice questions: clearly enter your letter answer in the appropriate location. **Circle** the letter which corresponds to your answer.
- For short answer questions: clearly **circle** your final answer, showing all work.

Point values and your exam score will be summarized on the final page.

Integrity statement:

I have neither given nor received aid on this exam.

_____

Your signature

1. Will a solid form when 0.1 M lead(II) nitrate is added to 0.3 M hydrochloric acid?

    a. yes
    b. no
    c. sometimes
    d. only on Fridays
    e. more information is needed to answer this question

Letter answer to question #1: _____

2. Which of the following is the solubility product constant for Fe_2S_3?

    a. $K_{sp} = [Fe^{2+}][S^{3-}]$
    b. $K_{sp} = [Fe^{2+}]^2[S^{3-}]^3$
    c. $K_{sp} = [Fe^{2+}][S^{2-}]^3$
    d. $K_{sp} = [Fe^{3+}][S^{2-}]^3$
    e. $K_{sp} = [Fe^{3+}]^2[S^{2-}]^3$

Letter answer to question #2: _____

3. Which of the following equations is the solubility product for magnesium iodate, $Mg(IO_3)_2$?

    a. $K_{sp} = [Mg^{2+}][I^{-1}]^2[O^{-2}]^6$
    b. $K_{sp} = [Mg^{2+}][I^{-1}]^2[3O^{-2}]^2$
    c. $K_{sp} = [Mg^{2+}][IO_3^{-1}]$
    d. $K_{sp} = [Mg^{2+}]^2[IO_3^{-1}]$
    e. $K_{sp} = [Mg^{2+}][IO_3^{-1}]^2$

Letter answer to question #3: _____

4. The solubility of $SrSO_4$ in water is 0.107 g in 1.0 L at 25 °C. What is the value of K_{sp} for $SrSO_4$?

    a. 3.4×10^{-7}
    b. 5.8×10^{-4}
    c. 1.2×10^{-3}
    d. 1.1×10^{-2}
    e. 2.1×10^{-1}

Letter answer to question #4: _____

5. The solubility of lead (II) chloride, $PbCl_2$, is 1.6×10^{-2} M. What is the K_{sp} of $PbCl_2$?

    a. 5.0×10^{-4}
    b. 4.1×10^{-6}
    c. 3.1×10^{-7}
    d. 1.6×10^{-5}
    e. 1.6×10^{-2}

Letter answer to question #5: _____

6. Calculate the maximum concentration (in M) of silver ions (Ag^+) in a solution that contains 0.025 M of CO_3^{2-}. The K_{sp} of Ag_2CO_3 is 8.1 x 10^{-12}.

    a. 1.8 x 10^{-5}
    b. 1.4 x 10^{-6}
    c. 2.8 x 10^{-6}
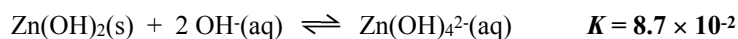   d. 3.2 x 10^{-10}
    e. 8.1 x 10^{-12}

Letter answer to question #6: _____

7. The K_{sp} for $Zn(OH)_2$ is 5.0 x 10^{-17}. Determine the molar solubility of $Zn(OH)_2$ in a buffer solution with a pH of 11.5.

    a. 5.0 x 10^6
    b. 1.2 x 10^{-12}
    c. 1.6 x 10^{-14}
    d. 5.0 x 10^{-12}
    e. 5.0 x 10^{-17}

Letter answer to question #7: _____
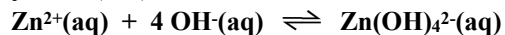

8. The molar solubility of _____ is not affected by the pH of the solution.

    a. Na_3PO_4
    b. NaF
    c. KNO_3
    d. $AlCl_3$
    e. MnS

Letter answer to question #8: _____

9. Consider the reaction
       $Zn(OH)_2(s)$ + 2 $OH^-(aq)$ $\rightleftharpoons$ $Zn(OH)_4^{2-}(aq)$ **$K = 8.7 \times 10^{-2}$**
    If K_{sp} for $Zn(OH)_2$ is **3.0×10^{-17}**, what is the value of the formation constant, K_{form}, for the reaction below?
       $Zn^{2+}(aq)$ + 4 $OH^-(aq)$ $\rightleftharpoons$ $Zn(OH)_4^{2-}(aq)$

    a. 2.6 x 10^{-18}
    b. 3.4 x 10^{-16}
    c. 2.9 x 10^{15}
    d. 3.3 x 10^{16}
    e. 3.8 x 10^{17}

Letter answer to question #9: _____

10. The following anions can be separated by precipitation as silver salts: Cl^{-1}, Br^{-1}, I^{-1}, CrO_4^{2-}. If Ag^+ is added to a solution containing the four anions, each at a concentration of 0.10 M, in what order will they precipitate?

Compound	K_{sp}
AgCl	1.8×10^{-10}
Ag_2CrO_4	1.1×10^{-12}
AgBr	5.4×10^{-13}
AgI	8.5×10^{-17}

   a. $AgCl \rightarrow Ag_2CrO_4 \rightarrow AgBr \rightarrow AgI$
   b. $AgI \rightarrow AgBr \rightarrow Ag_2CrO_4 \rightarrow AgCl$
   c. $Ag_2CrO_4 \rightarrow AgCl \rightarrow AgBr \rightarrow AgI$
   d. $Ag_2CrO_4 \rightarrow AgI \rightarrow AgBr \rightarrow AgCl$
   e. $AgI \rightarrow AgBr \rightarrow AgCl \rightarrow Ag_2CrO_4$

Letter answer to question #10: _____

11. _____ is reduced in the following reaction: $Cr_2O_7^{2-} + 6 S_2O_3^{2-} + 14 H^+ \rightarrow 2 Cr^{3+} + 3 S_4O_6^{2-} + 7 H_2O$

   a. Cr^{6+}
   b. S^{2+}
   c. H^{+1}
   d. O^{2-}
   e. $S_4O_6^{2-}$

Letter answer to question #11: _____

12. Which substance is the reducing agent in the following reaction: $Cr_2O_7^{2-} + 3 Ni + 14 H^+ \rightarrow 2 Cr^{3+} + 3 Ni^{2+} + 7 H_2O$

   a. Ni
   b. H^{+1}
   c. $Cr_2O_7^{2-}$
   d. H_2O
   e. Ni^{2+}

Letter answer to question #12: _____

13. The balanced half-reaction in which one mole of chlorine gas is reduced to the aqueous chloride ion is a _____ process.

   a. one-electron
   b. two-electron
   c. four-electron
   d. three-electron
   e. six-electron

Letter answer to question #13: _____

14. The half-reaction occurring at the **anode** in the balanced reaction shown below is _____.

$$3 \ MnO_4^{1-}(aq) \ + \ 5 \ Fe(s) \ + \ 24 \ H^+(aq) \ \rightarrow \ 3 \ Mn^{2+}(aq) \ + \ 5 \ Fe^{3+}(aq) \ + \ 12 \ H_2O(l)$$
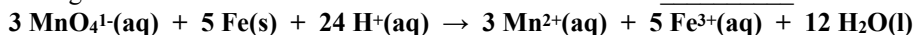
a. $MnO_4^{1-}(aq) \ + \ 8 \ H^+(aq) + 5 \ e^{1-} \ \rightarrow \ Mn^{2+}(aq) \ + \ 4 \ H_2O(l)$
b. $2 \ MnO_4^{1-}(aq) \ + \ 12 \ H^+(aq) + 6 \ e^{1-} \ \rightarrow \ 2 \ Mn^{2+}(aq) \ + \ 3 \ H_2O(l)$
c. $Fe(s) \ \rightarrow \ Fe^{3+}(aq) + 3 \ e^{1-}$
d. $Fe(s) \ \rightarrow \ Fe^{2+}(aq) + 2 \ e^{1-}$
e. $Fe^{2+}(aq) \ \rightarrow \ Fe^{3+}(aq) + e^{1-}$

Letter answer to question #14: _____

15. The standard cell potential ($E°_{cell}$) of the reaction below is **+0.126 V**. The value of **$\Delta G°$** for the reaction is _____ kJ/mol.

$$Pb(s) \ + \ 2 \ H^+(aq) \ \rightarrow \ Pb^{2+}(aq) \ + \ H_2(g)$$
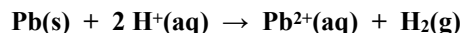
a. -24.3
b. +24.3
c. -12.6
d. +12.6
e. -50.8

Letter answer to question #15: _____

16. How many grams of Ca metal are produced by the electrolysis of molten $CaBr_2$ using a current of 30.0 amp for 10.0 hours?

a. 22.4
b. 448
c. 0.0622
d. 224
e. 112

Letter answer to question #16: _____

17. Which one of the following reactions is a redox reaction?

a. $NaOH(aq) + HCl(aq) \ \rightarrow \ NaCl(aq) + H_2O(l)$
b. $Pb^{2+}(aq) \ + 2 \ Cl^{1-}(aq) \ \rightarrow \ PbCl_2(aq)$
c. $AgNO_3(aq) \ + \ HCl(aq) \ \rightarrow \ HNO_3(aq) \ + \ AgCl(s)$
d. None of the above is a redox reaction.
e. All of the above are redox reactions

Letter answer to question #17: _____

18. What is the coefficient for Fe^{3+} when the following equation is **balanced**? $CN^{1-} \ + \ Fe^{3+} \ \rightarrow \ CNO^{1-} \ + \ Fe^{2+}, \ pH = 10.75$

a. 1
b. 2
c. 3
d. 4
e. 5

Letter answer to question #18: _____

19. The standard cell potential ($E°_{cell}$) of the reaction below is **-0.126 V**. When this reaction is set up as an electrochemical cell,

$$Pb^{2+}(aq) + H_2(g) \rightarrow Pb(s) + 2 H^+(aq)$$
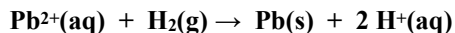
a. the reaction occurs until the chemicals are used up
b. the reaction does not occur under any circumstances
c. the reaction does not occur unless external voltage is applied which is less than 0.126 V
d. the reaction does not occur unless external voltage is applied which is more than 0.126 V
e. more than one answer is correct

Letter answer to question #19: _____

20. For the reaction given below: how will adding iron(III) nitrate affect the value of $E°_{cell}$?

$$3 MnO_4^{1-}(aq) + 5 Fe(s) + 24 H^+(aq) \rightarrow 3 Mn^{2+}(aq) + 5 Fe^{3+}(aq) + 12 H_2O(l)$$
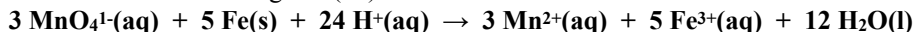
a. adding iron(III) nitrate will not affect the value of $E°_{cell}$
b. The value of $E°_{cell}$ will increase
c. The value of $E°_{cell}$ will decrease
d. $E°_{cell}$ will not change, but enthalpy will be affected
e. $E°_{cell}$ will not change, but entropy will be affected

Letter answer to question #20: _____

21. What is the correct cell notation for a voltaic cell based on the reaction below?
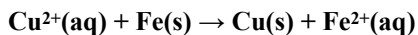
$$Cu^{2+}(aq) + Fe(s) \rightarrow Cu(s) + Fe^{2+}(aq)$$

a. Cu(s) | Cu²⁺(aq) || Fe²⁺(aq) | Fe(s)
b. Fe(s) || Fe²⁺(aq), Cu²⁺(aq) | Cu(s)
c. Cu(s) || Cu²⁺(aq), Fe²⁺(aq) || Fe(s)
d. Cu(s) | Fe²⁺(aq) || Cu²⁺(aq) | Fe(s)
e. Fe(s) | Fe²⁺(aq) || Cu²⁺(aq) | Cu(s)

Letter answer to question #21: _____

22. Use the standard reduction potentials below to determine which element or ion is the best oxidizing agent.

$O_2(g) + 4 H^+(aq) + 4 e^- \rightarrow 2 H_2O(l)$	$E° = +1.229$ V
$Hg_2^{2+}(aq) + 2 e^- \rightarrow 2 Hg(l)$	$E° = +0.789$ V
$I_2(s) + 2 e^- \rightarrow 2 I^-(aq)$	$E° = +0.535$ V

a. $I_2(s)$
b. $O_2(g)$
c. $I^-(aq)$
d. $Hg_2^{2+}(aq)$
e. $H_2O(l)$

Letter answer to question #22: _____

23. Consider the following half-reactions:

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

$Cu^{2+}(aq) + 2\ e^- \rightarrow Cu(s)$ $E° = +0.34$ V

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

$Fe^{2+}(aq) + 2\ e^- \rightarrow Fe(s)$ $E° = -0.44$ V

$Al^{3+}(aq) + 3\ e^- \rightarrow Al(s)$ $E° = -1.66$ V

Which of the above metals or metal ions will oxidize Pb(s)?

    a. $Ag^+(aq)$ and $Cu^{2+}(aq)$
    b.   Ag(s) and Cu(s)
    c. $Fe^{2+}(aq)$ and $Al^{3+}(aq)$
    d.   Fe(s) and Al(s)
    e. $Cu^{2+}(aq)$ and $Fe^{2+}(aq)$

Letter answer to question #23: _____

24. What is the reducing agent in the following electrochemical cell: Mg(s) | $Mg^{2+}(aq)$ || $Ni^{2+}(aq)$ | Ni(s)

    a.   Mg
    b. Mg^{2+}
    c. Ni^{2+}
    d.   Ni
    e. H_2O

Letter answer to question #24: _____

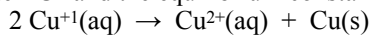25. What charge, in coulombs, is required to deposit 1.5 g Mg(s) from a solution of $Mg^{2+}(aq)$?

    a. 4.1×10^2 C
    b. 6.0×10^3 C
    c. 1.2×10^4 C
    d. 2.9×10^5 C
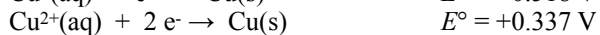   e. 3.1×10^6 C

Letter answer to question #25: _____

Part II: Short Answer / Calculation, 40 points total. *Show all work!*

1. You have a solution containing 0.010 M Hg_2^{2+}(aq). $K_{sp} = 1.1*10^{-18} = [Hg_2^{2+}][Cl^-]^2$ (10 points)

   a. Write the chemical reaction corresponding to the K_{sp} for Hg_2Cl_2 showing all states of matter, reactants and products.
   b. What is the concentration of chloride required to begin precipitation of Hg_2Cl_2?
   c. If 0.010 M chloride is added to the solution, what is the value of Hg_2^{2+} at this point?
   d. Would adding $NaNO_3$ affect the solubility of Hg_2Cl_2? Explain briefly.

2. Calculate $\Delta G°$ and the equilibrium constant, K_{eq}, for the disproportionation reaction (below) of Cu^{+1} at 25 °C:
   $$2\ Cu^{+1}(aq) \rightarrow Cu^{2+}(aq) + Cu(s)$$
   given the following thermodynamic information. (10 points)

Cu^+(aq) + e$^-$ → Cu(s)	$E° = +0.518$ V
Cu^{2+}(aq) + 2 e$^-$ → Cu(s)	$E° = +0.337$ V

3. You decide to assemble an electrochemical cell based on the half reactions $Mg^{2+} / Mg_{(s)}$ and $Ni^{2+} / Ni_{(s)}$.   (10 points)

   a.   Write the equation for the product favored reaction that occurs in the cell.

   b.   Calculate E° for this product-favored reaction at 25 °C. *Use the table at the end of the exam.*

   c.   What is the better reducing agent, Mg or Ni?   _____

   d.   Calculate E_{cell} for this reaction at 25 °C when $[Ni^{2+}] = 0.10$ M and $[Mg^{2+}] = 0.90$ M. *(Hint: be sure to use the Nernst equation,* $E = E° - (RT/nF) \ln Q$*)*

   e.   Do electrons flow from the Mg electrode to the Ni electrode or from Ni to Mg??

4. a. Write your name on the front page of the exam in the designated area (5 points)

    b. What is the name of the lion who says "GER" in the redox chapter? (5 points)   _____

    c. *(circle one)* Which would, in general, make a better reducing agent: **metals**   **nonmetals**   **metalloids**   (5 points)

*Avoid a point penalty - do **not** write on this page!*

Multiple choice questions:

_____   X *4 points per question*   =   _____ points
number of multiple choice
questions correct

Short answer questions:

_____ points

Total points on this exam: _____ points

Grade	Percentage	Points on This Exam
A	90% - 100%	126 - 140
B	80% - 89%	112 - 125
C	70% - 79%	98 - 111
D	60% - 69%	84 - 97
F	0% - 59%	0 - 83

CH 223 Sample Exam II *Answers*

Part I: Multiple Choice Questions

1. A
2. E
3. E
4. A
5. D

6. A
7. D
8. C
9. C

10. E
11. A
12. A
13. B

14. C
15. A
16. D
17. D
18. B

19. D
20. C
21. E
22. B

23. A
24. A
25. C

Part II: Short Answer / Calculation.

1. Mercury question:
    a. $Hg_2Cl_2(s) \rightleftharpoons Hg_2^{2+}(aq) + 2\ Cl^-(aq)$

    b. 1.0×10^{-8} M
    c. $1.1 * 10^{-14}$ M
    d. no
2. $\Delta G = -34.9$ kJK, K = 1.3×10^6
3. Electrochemical cell question:
    a. $Mg + Ni^{2+} \rightarrow Mg^{2+} + Ni$
    b. 2.12 V
    c. Mg
    d. 2.09 V
    e. from Mg to Ni
4. Questions
    a. :)
    b. LEO
    c. metals