CHEMISTRY 102 EXAM 4
SECTIONS 529-537 Dr. Joy Heising

FORM 4C
April 22, 2002

Directions:
1. This examination consists of two parts: 12 multiple choice questions (5 points each) in Part 1 and 3 free response questions (40 points total) in Part 2. The total point value for the exam is 100 points.
2. Fill out your scantron sheet to be used for Part 1.
   a. Do not forget to include your SIGNATURE and ID number.
   b. Dept = CHEM, Course No. = 102
   c. If you want your scores posted, mark A under the option column
3. Fill in your NAME, SIGNATURE and ID number at the beginning of Part 2 (stapled separately).
4. Use a #1 or #2 pencil for marking the scantron. Fill in the appropriate circles completely. You may write on the multiple choice questions.
5. Read each question carefully, then choose the best answer for each question. There is no penalty for guessing.
6. Write your answers in Part 2 clearly and neatly. Show your work for partial credit.
7. DO NOT write on the envelope.
8. The last page of each Part is a sheet of scrap paper. You may tear it off.
9. When finished, put the SCANTRON SHEET AND PART 2 back in the envelope and turn it in. You may keep Part 1 (this stapled portion).

Some constants/equations:

1 mol gas = 22.4 L at STP

1 Faraday = 9.65 x 10⁴ Coulombs
PART 1

Multiple Choice (5 points each). Choose the BEST answer.

1. Which of the following solubility product expressions is incorrect?
   a) \( K_{sp}(\text{Sb}_2\text{S}_3) = [\text{Sb}^{3+}]^2[\text{S}^{2-}]^3 \)
   b) \( K_{sp}(\text{MnCO}_3) = [\text{Mn}^{2+}][\text{CO}_3^{2-}] \)
   c) \( K_{sp}(\text{Hg}_2\text{Cl}_2) = [\text{Hg}^{2+}]^2[\text{Cl}]^2 \)
   d) \( K_{sp}(\text{SrCrO}_4) = [\text{Sr}^{2+}][\text{Cr}^{6+}][\text{O}^{2-}]^4 \)
   e) \( K_{sp}(\text{Ag}_2\text{S}) = [\text{Ag}^+]^2[\text{S}^2] \)

2. Calculate the molar solubility of Al(OH)_3 at 25ºC. \( K_{sp} = 1.9 \times 10^{-33} \).
   a) \( 1.2 \times 10^{-9} \text{ M} \)
   b) \( 4.2 \times 10^{-15} \text{ M} \)
   c) \( 2.9 \times 10^{-9} \text{ M} \)
   d) \( 4.4 \times 10^{-14} \text{ M} \)
   e) \( 9.3 \times 10^{-9} \text{ M} \)

3. SnI\(_2\) would be least soluble at 25ºC in
   a) pure water
   b) 0.10 M HI
   c) 0.10 M BaI\(_2\)
   d) 0.10 M Sn(NO\(_3\))\(_2\)
   e) it is equally soluble in all the preceding substances

4. How many grams of PbSO\(_4\) will dissolve in 1.0 L of 0.25 M K\(_2\)SO\(_4\)? \( K_{sp} = 1.8 \times 10^{-8} \), molar mass PbSO\(_4\) = 303.2 g/mol
   a) \( 5.5 \times 10^{-6} \)
   b) \( 2.2 \times 10^{-5} \)
   c) \( 4.1 \times 10^{-2} \)
   d) \( 1.4 \times 10^{-6} \)
   e) \( 5.2 \times 10^{-7} \)

5. If solid NaCl is added to a 0.010 M solution of AgNO\(_3\) in water at 25ºC, at what \([\text{Cl}^-]\) does precipitation of AgCl begin? \( K_{sp} = 1.8 \times 10^{-10} \)
   a) \( 1.0 \times 10^{-10} \text{ M} \)
   b) \( 1.3 \times 10^{-6} \text{ M} \)
   c) \( 1.8 \times 10^{-8} \text{ M} \)
   d) \( 1.8 \times 10^{-12} \text{ M} \)
   e) \( 1.3 \times 10^{-10} \text{ M} \)
6. If equal amounts of Cd$^{2+}$, Fe$^{2+}$, Mn$^{2+}$, Pb$^{2+}$, and Zn$^{2+}$ are present in aqueous solution, and an increasing amount of solid Na$_2$S (a soluble salt) is added gradually, which solid will precipitate from solution first?

a) CdS  $K_{sp} = 3.6 \times 10^{-29}$  
b) FeS  $K_{sp} = 4.9 \times 10^{-18}$  
c) MnS  $K_{sp} = 5.1 \times 10^{-15}$  
d) PbS  $K_{sp} = 8.4 \times 10^{-28}$  
e) ZnS  $K_{sp} = 1.1 \times 10^{-21}$

7. The $K_{sp}$ for Fe(IO$_3$)$_3$ is $\sim 10^{-14}$. Two solutions are mixed, one containing Fe$^{3+}$ and the other containing IO$_3^-$ at 25ºC. At the instant of mixing, the molarity of [Fe$^{3+}$] = $10^{-4}$ M and [IO$_3^-$] = $10^{-5}$ M (in the combined solutions.) Which of the following statements is true?

a) A precipitate forms because $Q_{sp} > K_{sp}$  
b) A precipitate forms because $Q_{sp} < K_{sp}$  
c) No precipitate forms because $Q_{sp} > K_{sp}$  
d) No precipitate forms because $Q_{sp} < K_{sp}$  
e) none of the above

8. In any electrochemical cell, the anode is always ______________.

a) the positive electrode  
b) the negative electrode  
c) the electrode at which some species gains electrons  
d) the electrode at which some species loses electrons  
e) both a and c

9. Which of the following statements about electrolysis is incorrect?

a) a liquid media (such as aqueous solution or molten salt) is used because the ions must be able to move freely  
b) it requires a battery or other external source of electrical current  
c) the species that is most easily oxidized will be oxidized  
d) electroplating is a practical application of electrolysis  
e) the reactants will usually react with each other if mixed together

10. A 1.75 ampere current flows for 4.60 minutes. How many moles of electrons does this represent?

a) 483 mol e$^-$  
b) 8.05 mole e$^-$  
c) 0.0050 mol e$^-$  
d) 8.35 x $10^{-3}$ mol e$^-$  
e) 9.05 x $10^{-6}$ mol e$^-$
11. How many grams of metallic nickel can be produced by the electrolysis of aqueous nickel (II) chloride, NiCl₂, with a 0.350 A current for 5.00 hours?

a) 1.19 g  
b) 1.92 g  
c) 7.66 g  
d) 2.76 g  
e) 3.83 g

12. Consider the following oxidation:

\[ 2\text{H}_2\text{O} (l) \rightarrow \text{O}_2 (g) + 4\text{H}^+(aq) + 4\text{e}^- \]

For how many days would 1.5 A current have to flow to produce 8.0 L of \( \text{O}_2 (g) \) at STP?

a) 1.06 days  
b) 1.43 days  
c) 1.49 days  
d) 2.40 days  
e) 3.35 days
Free Response (40 pts total, see margin for point values). Show all work for partial credit!

(10) 1. Consider the following two ½ cells:

A 1.0 M CuSO₄ solution and pure Cu metal electrode
A 1.0 M Cr(NO₃)₃ solution and pure Cr metal electrode

When combined to form a galvanic (voltaic) cell, the mass of the Cr electrode decreases whereas the mass of the Cu electrode increases.

The _____________ is oxidized to _________________.

The _____________ is reduced to _________________.

Write the appropriate ½ reactions for each ½ cell, the balanced net ionic equation, and the shorthand notation for this cell.
2. Complete the following spontaneous redox reaction (balanced!):

\[ 2\text{Ga} (s) + 3\text{Co}^{2+} (aq) \rightarrow \text{___________} (aq) + \text{__________} (s) \]

The type of cell is (circle) electrolytic voltaic (galvanic)

Draw a diagram of the electrochemical cell containing the reactants and products of this reaction.
Label the following:
- Anode and cathode
- Electron flow and ion flow (if salt bridge required, use KCl)
- Signs of the electrodes
3. 150.0 mL of a solution initially 0.005 M in CaCl₂ was added to 600.0 mL of a solution initially 0.00125 M in Na₂C₂O₄ (sodium oxalate). Calculate the mass of calcium oxalate (CaC₂O₄) formed. \( K_{sp} = 2.3 \times 10^{-9} \). Molar mass CaC₂O₄ = 128 g/mol.
SCRAP PAPER (PART 2)