Dr. Bolaños **CHEM 111- Exam 4** **Spring 2015**

There are 14 questions totaling 103 (scored out of 100) points. PLEASE look over the entire examination (7 test pages; 10 pages total) BEFORE you begin to ensure your packet is complete. REMEMBER: The best place to start your exam may not be at the beginning! You have 2.75 hours to complete this examination and may only use a basic scientific calculator, the resource sheet and the periodic table provided. For Questions 9 -14, all work must be shown for credit. Please sign the honor code at the end of the document, when complete. If you need further clarification, please speak with the instructor. ****** I certify that the work presented in this examination is my own and that the rules set-forth for this examination were followed.***

Signature: _____

Questions 1-8: Each response/blank is worth 1.5 pts, unless noted otherwise. (22 pts total)

1. An loss of electrons denotes this redox process: _____; a reducing agent *gains* ***or*** *loses* **(circle one)** electrons.

2. In a galvanic cell, the anion from the salt bridge flows into the_____; electrons flow towards the _____ .

3. Consider emitted radiation from nuclear processes. _____have the lowest ionizing power . Gamma particles can be halted with _____. Which process generates more energy per gram: fission ***or*** fusion? This equipment/apparatus in the core prevents the meltdown of a nuclear power plant_____. The greater the mass defect, the _____ stable the binding energy of the formed nuclide.

4. In a electrolytic cell, E^{o}_{cell} is positive ***or*** negative **(circle one)** , and the cathode is connected to the _____ terminal of a power supply.

5. Which one of the following materials would be least suitable for use as an electrode material in the following standard half-cell: $Fe^{3+} + e^{-} \longrightarrow Fe^{2+}$ $E^{o} = 0.77$ V

   a. platnium b. silver c. carbon d. Iron

6. Please consider the two substances below and fill-in the table, as requested. (4 pts total)

Substance	**IF RADIOACTIVE**, *Predicted Emission Type*
Co-51	
Te-124	

7. During electron capture, the atomic number of formed nuclide: _____.

   Possible fill-in answers: ***increases by x, decreases by y, or remains unchanged.*** You supply x and y, as needed.

8. Consider Table 1, below, and answer questions a-f below. **SHOW PHASE LABELS in your answers.** ***No partial credit.*** (14 pts total; 2 pts each)

Table 1: Standard potentials of various half-reactions

Half Reaction	E°(V)
$Cd^{2+} + 2e^- \rightarrow Cd\ (s)$	-0.40
$Pb^{2+} + 2e^- \rightarrow Pb\ (s)$	-0.13
$Cu^{2+} + 2e^- \rightarrow Cu\ (s)$	+ 0.34
$Fe^{3+} + e^- \rightarrow Fe^{2+}\ (aq)$	+0.77
$Au^{3+} + 3e^- \rightarrow Au(s)$	+1.50

   a. The unbalanced reaction that would produce the most favorable (spontaneous) ΔG is:

      _____.

   b. The strongest reducing agent is _____ and the weakest oxidizing agent is

      _____.

   c. Which substance is most difficult to oxidize? _____

   d. Can Cu^{2+} oxidize Fe^{2+} ? _____

   e. A substance from Table 1, Question 7, that can be oxidized by HIO_3 *, but <u>not</u> HCl is:

      _____ . **See half-reaction in Resource Section*

   f. The reaction: $Pb^{2+} + Fe^{2+} \longrightarrow Fe^{3+} + Pb$, occurs spontaneously in the reverse direction.

      <u>True ***or*** False?</u>

9. Please write a balanced nuclear reaction for each the following. **No partial credit here!** *(12 pts total; 3 pts each)*
    a. O-17 undergoing positron emission:

    b. Reaction showing creation of a beta particle:

    c. A neutron induced reaction of Am-244 to form I-134, Mo-107 and neutron(s):

    d. The partial decay series of At-218 is alpha, beta, beta. Please show the nuclear reaction representing the second decay.

10. You are asked to put together a *galvanic* cell using the Pb/Pb^{2+} and Cr^{3+}/Cr^{2+} and couples. **NO PARTIAL CREDIT FOR ANY PARTS of this problem. Be careful!** (16 pts total)

a. Provide the shorthand notation for the galvanic cell, under standard conditions **and** circle the substance oxidized in notation. (5 pts)

b. The half- reaction that would occur in the anode would be: (3 pts):

_____

c. Calculate the equilibrium constant, under standard conditions, for this galvanic cell. (4 pts).

d. If the concentrations of each aqueous substance in the galvanic cell were 0.15 M, the potential of the cell is _____ V. (4 pts)

11. Write the balanced redox equation for the reaction below in <u>basic</u> solution. Show work for credit. (8 pts)

$$MnO_4^-{}_{(aq)} + Br^-{}_{(aq)} \longrightarrow Mn^{2+}{}_{(aq)} + Br_{2\,(l)}$$ **(Basic solution)**

12. How long (in minutes) must a constant current of 41.0 A be passed through an electrolytic cell containing aqueous Cu^{2+} ions to produce 5.00 moles of copper metal? (7 pts)

13. A nuclear "intern" determines that an Australian rock contains 0.7008 g Pb-206 to every 1.749 g U-238. U-238 decays to Pb-206 with a half-life of 4.5 billion years. (12.5 pts total)

    a. Assuming that the rock did not contain Pb-206 at the time of formation, how old is the rock? (8 pts)

    b. How many decays has the U-238 emitted? (4.5 pts)

14. Oh, the power of nuclear reactions! Calculate the energy produced per gram of reactants for reaction below. The mass of H-2 is 2.014102 amu, He-3 is 3.016029 amu and the mass of neutron is 1.00866492 amu. **Show all work for credit.** (10 pts)

$$^{2}_{1}\mathrm{H} + {}^{2}_{1}\mathrm{H} \rightarrow {}^{3}_{2}\mathrm{He} + {}^{1}_{0}\mathrm{n}$$

Scratch Sheet **NAME**_____

REFERENCE SHEET

1 A = 1 C/s
F= 96,485 C/mol e^-

1V = 1 J/C
$\Delta G^o = -nFE^o$

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

$E_{cell} = E^o_{cell} - \frac{0.0592}{n} \log Q$

Rate = kN

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

$\ln \left(\frac{Nt}{No}\right) = -kt$

$E = mc^2$

F= 96,485 C/mol e^-
1 amu = $1.66053873 \times 10^{-27}$ kg
c = 2.9979×10^8 m/s
1 e^- = 1.609×10^{-19} J

Select Standard Potentials

$IO_3^-(aq) + 6H^+(aq) + 5e^- \longrightarrow \frac{1}{2} I_2(aq) + 3 H_2O_{(l)}$ $E^o = 1.20$ V

$NO_3^-(aq) + 4H^+(aq) + 3e^- \longrightarrow NO(g) + 2 H_2O_{(l)}$ $E^o = 0.96$ V

$Hg^{2+} + 2e^- \longrightarrow Hg_{(l)}$ $E^o = 0.854$ V

$2H^+ + 2e^- \longrightarrow H_2$ $E^o = 0.00$ V

$Pb^{2+} + 2e^- \longrightarrow Pb$ $E^o = -0.13$ V

$Cr^{3+} + e^- \longrightarrow Cr^{2+}$ $E^o = -0.50$ V