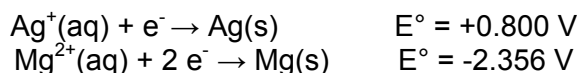


Please follow the instructions for each section of the exam. Show your work on all mathematical problems. Provide answers with the correct units and significant figures. Be concise in your answers to discussion questions.

Complete all of questions 1-6.

1. Is the reaction: $\text{Mg(s)} + 2\text{AgNO}_3(\text{aq}) \rightarrow 2\text{Ag(s)} + \text{Mg(NO}_3)_2(\text{aq})$ spontaneous and why?



- a. no, E° is a positive value c. yes, E° is a negative value
b. yes, E° is a positive value d. no, E° is a negative value Answer _____

2. Write the net redox reaction that occurs in the following galvanic cell.



- a. $2 \text{Ti}^{3+}(\text{aq}) + 3 \text{Se(s)} + 1 \text{e}^- \rightarrow 2 \text{Ti(s)} + 3 \text{Se}^{2-}(\text{aq})$
b. $2 \text{Ti(s)} + 3 \text{Se(s)} \rightarrow 2 \text{Ti}^{3+}(\text{aq}) + 3 \text{Se}^{2-}(\text{aq})$ Answer _____
c. $\text{Ti(s)} + \text{Se(s)} \rightarrow \text{Ti}^{3+}(\text{aq}) + \text{Se}^{2-}(\text{aq}) + 1 \text{e}^-$
d. $2 \text{Ti}^{3+}(\text{aq}) + 3 \text{Se(s)} \rightarrow 2 \text{Ti(s)} + 3 \text{Se}^{2-}(\text{aq})$

NOTE: Everyone was given credit for this question because the correct answer was not listed. The correct answer is the reverse of answer d: $2 \text{Ti} + 3 \text{Se}^{2-} \rightarrow 2 \text{Ti}^{3+} + 3 \text{Se}$

3. In the cation $[\text{CoCl}_2(\text{en})_2]^+$, the oxidation state of cobalt and its coordination number, respectively, are:

- a. +2 and six c. -4 and six
b. +4 and four d. +3 and six Answer _____

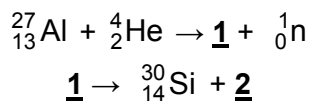
4. Ligands approaching in a tetrahedral pattern cause some d-orbitals to be raised in energy. How many orbitals are on the higher energy level?

- a. 2 c. 4
b. 3 d. 5 Answer _____

5. Which one of the following leaves both atomic number and mass number unchanged?

- a. alpha emission c. gamma emission
b. beta emission d. neutron emission Answer _____

6. Consider the following nuclear reactions. What are the nuclides 1 and 2, respectively?



- a. ${}_{15}^{30}\text{P}$ and ${}_{+1}^0\beta$ c. ${}_{12}^{30}\text{Mg}$ and $2 {}_{+1}^0\beta$ Answer _____
b. ${}_{14}^{30}\text{Si}$ and ${}_{-1}^0\beta$ d. ${}_{16}^{30}\text{S}$ and ${}_{-1}^0\beta$

Complete four (4) of problems 7-11. Clearly mark the problem you do not want graded. 12 points each.

7. Sketch the galvanic cell that would result if the components below were combined. Separate the anode and the cathode half cells and label each. Indicate the direction of electron flow and calculate the E° for the reaction.

Cell components: Sn metal, Cu metal, 1 M Cu^{2+} , 1 M Sn^{2+}

8. Briefly explain the similarities and differences between the two terms in **one** of the pairs below.
- galvanic cell compared to electrolytic cell
 - battery compared to fuel cell

9. Complete the following table.

Formula	$fac-[Fe(H_2O)_3(OH)_3]^+$	
Name		<i>trans</i> -triamminedichloronitrito-O-cobalt (III)
Metal oxidation state		
Coordination number		
Sketch		

10. You have been asked back to your high school chemistry class to lead a class discussion on one of the following topics. Select a topic and **outline** at least five key concepts that you would share with the class so that they would get a clear picture of the fundamentals and limitations of the topic.

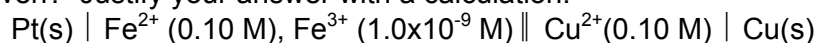
radiocarbon dating **OR** fission-based nuclear power

11. Approximately what mass of a 1.00-mg sample of ^{131}I remains after 40.2 days? The half-life of ^{131}I is 8.04 days.

Answer two (2) of problems 12-14. If you work on all three problems, clearly mark the problem you do not want graded. 15 points each.

12. You have synthesized a new, neutral, bidentate ligand (L) and are trying to determine where it fits in the spectrochemical series. You complex the ligand with cobalt to form $[\text{CoL}_3]^{3+}$ and characterize the resulting ion, determining that the ion is diamagnetic. Based on this information, is your new ligand a strong field or weak field ligand? Explain your reasoning, using orbital energy diagrams where appropriate.

13. Consider the cell shown in shorthand notation below. Is the reaction spontaneous under the conditions given? Justify your answer with a calculation.



14. Many commercial smoke detectors use a minute amount of radioactive americium-241 (^{241}Am), which decays initially by alpha-particle production. The alpha particles ionize molecules in the air, allowing it to conduct an electric current. When smoke particles enter, the conductivity of the air changes and an alarm sounds. The complete decay of ^{241}Am involves successively α , α , β , α , α , β , α , α , α , β , α , and β production.

a. Write reactions corresponding to the first three steps in this decay series?

b. What is the final stable nucleus produced in this decay series?

Possibly Useful Information

$\Delta G = \Delta H - T\Delta S$	$\Delta G = -nFE$	$E = E^\circ - \frac{2.303RT}{nF} \log Q$
$R = 8.31441 \text{ J/molK}$	$F = 96485 \text{ C/mol e}^-$	$\frac{2.303RT}{F} = 0.05916 \text{ V at } 25^\circ\text{C}$
$E = mc^2 = 1.49 \times 10^{-10} \text{ J/amu}$	$t_{1/2} = 0.693/\lambda$	$\ln\left(\frac{N}{N_0}\right) = -\lambda t$

Selected Standard Reduction Potentials

All species aqueous (aq) unless otherwise noted

Reaction	E°, V	Reaction	E°, V
$\text{Pt}^{2+} + 2\text{e}^- \rightarrow \text{Pt(s)}$	+1.180	$\text{Sn}^{2+} + 2\text{e}^- \rightarrow \text{Sn(s)}$	-0.137
$\text{Fe}^{3+} + \text{e}^- \rightarrow \text{Fe}^{2+}$	+0.771	$\text{Fe}^{2+} + 2\text{e}^- \rightarrow \text{Fe(s)}$	-0.440
$\text{Cu}^{2+} + 2\text{e}^- \rightarrow \text{Cu(s)}$	+0.340	$\text{Se(s)} + 2\text{e}^- \rightarrow \text{Se}^{2-}$	-0.670
$\text{Sn}^{4+} + 2\text{e}^- \rightarrow \text{Sn}^{2+}$	+0.154	$\text{Ti}^{3+} + 3\text{e}^- \rightarrow \text{Ti(s)}$	-0.900
$2\text{H}^+ + 2\text{e}^- \rightarrow \text{H}_2(\text{g})$	0.000	$\text{Al}^{3+} + 2\text{e}^- \rightarrow \text{Al(s)}$	-1.676

Weak Field $\text{I}^- < \text{Br}^- < \text{Cl}^- < \text{F}^- < \text{OH}^- < \text{C}_2\text{O}_4^{2-} \approx \text{H}_2\text{O} < \text{NH}_3 < \text{en} < \text{NO}_2^- < \text{CN}^-$ Strong Field

1 1A	2 2A																		18 8A						
1 H 1.00794																			2 He 4.00260						
3 Li 6.941	4 Be 9.01218																		5 B 10.811	6 C 12.011	7 N 14.0067	8 O 15.9994	9 F 18.9984	10 Ne 20.1797	
11 Na 22.9898	12 Mg 24.3050	3B	4B	5B	6B	7B	8B	9B	10B	11B	12B	13 Al 26.9815	14 Si 28.0855	15 P 30.9738	16 S 32.066	17 Cl 35.4527	18 Ar 39.948								
19 K 39.0983	20 Ca 40.078	21 Sc 44.9559	22 Ti 47.88	23 V 50.9415	24 Cr 51.9961	25 Mn 54.9381	26 Fe 55.847	27 Co 58.9332	28 Ni 58.693	29 Cu 63.546	30 Zn 65.39	31 Ga 69.723	32 Ge 72.61	33 As 74.9216	34 Se 78.96	35 Br 79.904	36 Kr 83.80								
37 Rb 85.4678	38 Sr 87.62	39 Y 88.9059	40 Zr 91.224	41 Nb 92.9064	42 Mo 95.94	43 Tc (98)	44 Ru 101.07	45 Rh 102.906	46 Pd 106.42	47 Ag 107.868	48 Cd 112.411	49 In 114.818	50 Sn 118.710	51 Sb 121.757	52 Te 127.60	53 I 126.904	54 Xe 131.29								
55 Cs 132.905	56 Ba 137.327	57 *La 138.906	72 Hf 178.49	73 Ta 180.948	74 W 183.84	75 Re 186.207	76 Os 190.23	77 Ir 192.22	78 Pt 195.08	79 Au 196.967	80 Hg 200.59	81 Tl 204.383	82 Pb 207.2	83 Bi 208.980	84 Po (209)	85 At (210)	86 Rn (222)								
87 Fr (223)	88 Ra 226.025	89 *Ac 227.028	104 Rf (261)	105 Db (262)	106 Sg (266)	107 Bh (264)	108 Hs (277)	109 Mt (268)	110 Ds (271)	111 Rg (272)															

*Lanthanide series	58 Ce 140.115	59 Pr 140.908	60 Nd 144.24	61 Pm (145)	62 Sm 150.36	63 Eu 151.965	64 Gd 157.25	65 Tb 158.925	66 Dy 162.50	67 Ho 164.930	68 Er 167.26	69 Tm 168.934	70 Yb 173.04	71 Lu 174.967
†Actinide series	90 Th 232.038	91 Pa 231.036	92 U 238.029	93 Np 237.048	94 Pu (244)	95 Am (243)	96 Cm (247)	97 Bk (247)	98 Cf (251)	99 Es (252)	100 Fm (257)	101 Md (258)	102 No (259)	103 Lr (262)

Copyright © 2007 Pearson Prentice Hall, Inc.