Name: _____

Chemistry 142 Electrochem & Coordination Chem Practice (Exam #3 Review)

Part I Electrochemistry

Question 1. Balance the following redox reactions.

a) $HI + HNO_3 \rightarrow I_2 + NO$

b) $Ag + H_2SO_4 \rightarrow Ag_2SO_4 + SO_2$

c) $MnCl_2 + KMnO_4 + KOH \rightarrow MnO_2 + KCl$

d) $H_3AsO_4 + Zn + HNO_3 \rightarrow AsH_3 + Zn(NO_3)_2$

e) $P_4 + NaOH \rightarrow NaH_2PO_4 + PH_3$

Name: _____

Question 2. Potassium was discovered by Sir Humphry Davy when he electrolyzed molten potassium hydroxide. Show this electrolytic cell and the electrode reactions.

Question 3. An iron rod is placed in 1.0*M* iron(III) chloride solution and a zinc rod is placed in a 1.0*M* zinc sulfate solution. Diagram this cell, give the cell potential, and give the shorthand notation.

Name: _____

Question 4. Calculate the standard free energy change, using electrochemical potentials, for the reaction,

$$Na(s) + \tfrac{1}{2}\, Cl_2(g) \rightarrow Na^+ + Cl^-$$

Question 5. What is the emf of the following cell?

$$Ni(s)|Ni^{2+}(1.0M)||Sn^{2+}(1.0\times10^{-4}M)|Sn(s)$$

Question 6. Calculate the equilibrium constant for the following reaction at 298 K.

$$Fe^{3+} + Sn^{2+} \rightarrow Fe^{2+} + Sn^{4+}$$

Name: _____

Question 7. The commercial production of Cl_2 involves the electrolysis of aqueous NaCl solutions. Give the products of this electrolysis at each electrode and calculate how long it will take to produce 1.18 kg of Cl_2 when a current of 5.00×10^2 A is applied.

Question 8. Diagram a lead-acid storage battery. Show the reactions that occur at each electrode and calculate the cell potential.

Question 9. What is a sacrificial anode?

Name: _____

Part II Coordination Chemistry

Question 1. Write the formula for the complex ion, and the coordination compounds containing the indicated central atom, ligands, and counter ion.

a) central atom: Fe^{3+}, ligands: six CN^-, counter ion: K^+

b) central atom: Ag^+, ligands: two OH^-, counter ion: Na^+

c) central atom: Ni^{2+}, ligands: four NH_3, counter ion: SO_4^{2-}

d) central atom: Pt^{4+}, ligands: four H_2O, two Cl^-, counter ion: Cl^-

Name: _____

Question 2. Find the coordination number and oxidation number of the central atom in each coordination compound below.

	Central Atom	Oxidation No.	Coordination No.
$K_2[PtCl_6]$			
$[Fe(H_2O)_6](NO_3)_2$			
$Na_2[Ni(CN)_4]$			
$[Zn(H_2O)_2(OH)_2]$			

Question 3. In the blanks give the formula indicating the composition of the complex and the counter ions for the coordination compounds below.

Composition	moles Cl^-/mol compound	Total no. of ions	Formula of Coord. Compound
$PtCl_4(NH_3)_6$	four	five	$[Pt(NH_3)_6]Cl_4$
$PtCl_4(NH_3)_4$	two	three	
$PtCl_4(NH_3)_2$	none	one	
$PtCl_4(NH_3)K$	none	two	

Question 4. Complete the table below

Form. of Coord. Compound	Formula of Complex Ion	Formula of Counter Ion	Total No. of Ions
$[Cr(H_2O)_6]Cl_3$			
$[Cr(H_2O)_5Cl]Cl_2$			
$[Cr(H_2O)_4Cl_2]Cl$			
$NH_4[Cr(H_2O)_2Cl_4]$			

Name: _____

Question 5. For each complex below, give the coordination number of the central atom, and the expected geometry of the complex.

	Coord. No. of Central Atom	**Geom. of Complex**
$[Fe(H_2O)_6]^{3+}$		
$[Ni(NH_3)_2Cl_2]$ (only one isomer)		
$[Ni(H_2O)_3(NH_3)_3]^{2+}$		
$[Au(CN)_2Cl_2]^-$ (two isomers)		

Question 6. Draw structures for the two isomers of $[Ni(NH_3)_2(H_2O)_3]^{2+}$.

Question 7. Draw structures for the two isomers of $[Pt(H_2O)_2(NH_3)Cl]^+$.

Name: _____

Question 8. Give the oxidation number and coordination number of the central atom in each complex below.

Complex	**Ox. No. of Central Atom**	**Coord. No. of Central Atom**
$[Ni(en)_3]^{2+}$		
$[Co(CO_3)_3]^{3-}$		
$[Pt(C_2O_4)_2]^{2-}$		
$[Ni(dmg)_2]$		

Question 9. Draw structures for the two isomers of $[Cr(C_2O_4)_2(H_2O)_2]^-$

Name: _____

Question 10. Name each of the following.

$[Cu(NH_3)_4]SO_4$	
$[Co(H_2O)_4Br_2]Br$	
$K[Cr(NH_3)_2Cl_4]$	
$Na_2[Zn(OH)_4]$	
$K_3[Co(C_2O_4)_3]$	

Question 11. Write the formula for the following compounds.

a) hexaamminenickel(II) sulfate

b) dichlorobis(ethylenediamine)cobalt(III) chloride

Question 12. What is the color of a substance that absorbs yellow light?

Question 13. The substance that gives leaves their green color is chlorophyll. Approximately what wavelength of light does chlorophyll absorb?

Question 14. In each pair of substances below, circle the one that absorbs light of higher energy. The observed color of each substance is indicated.

a) Substance A (yellow), substance B (green)

b) Substance B (green), substance C (violet)

c) Substance D (red), substance E (blue)

d) Substance C (violet), substance F (orange)

Name: _____

Question 15. Draw the crystal field splitting diagrams for $[Ni(H_2O)_6]^{2+}$, which is green, and$[Ni(NH_3)_6]^{2+}$, which is blue. Label the *d*-orbitals and place the nickel(II) valence electrons into the orbitals. Show only the ground state configuration.

Question 16. Which complex has the larger Δ?

Question 17. What is the approximate value of Δ in kJ/mol for $[Ni(H_2O)_6]^{2+}$? Use the color of the complex to estimate the value.

Name: _____

Question 18. Consider the two complex ions, $[Mn(H_2O)_6]^{2+}$ and $Mn[(CN)_6]^{4-}$. The first is pale red and is a high-spin complex, while the second is a low-spin complex.

a) Sketch the crystal field splitting energy diagram for $[Mn(H_2O)_6]^{2+}$. Label each orbital and put in the electron.

b) Do the same for $Mn[(CN)_6]^{4-}$.

c) What is the color of the light absorbed by $[Mn(H_2O)_6]^{2+}$?

d) Based on the magnitude of its Δ compared to that of the H_2O complex, what color of light might be absorbed by $[Mn(CN)_6]^{4-}$?

e) What color is a solution of $[Mn(CN)_6]^{4-}$ likely to be?

Name: _____

Question 19. The magnitude of splitting of orbital energies of a transition metal ion depend upon the identity of the ligand. Based on the color of the complexes in the table below, arrange the ligands in order of the magnitude of splitting they cause, beginning with the ligand causing the smallest Δ.

Complex	Color	Complex	Color
$[Co(H_2O)_6]^{3+}$	pale red	$[Co(CN)_6]^{3-}$	yellow
$[Co(NH_3)_6]^{3+}$	pale orange	$[Co(CO_3)_3]^{3-}$	green

Least _____ < _____ < _____ < _____ Greatest

Question 20. $Ni(CN)_4^{2-}$ is yellow and has no unpaired electrons. $NiCl_4^{2-}$ is deep blue and has two unpaired electrons.

a) Which complex is high spin and which is low spin?

b) What is the correct geometry for each complex ion?

c) Sketch the correct splitting energy diagram for each complex ion. Label each orbital and fill in the electrons.