Chem1C, Sp 06, FH, Lec Exam2 Name KEY

Show the set up before calculating your math problems. Write your questions **clearly** and using the **correct units** to get full points. For multiple choice and similar problems, show the calculation on the reverse page to get partial points. ($\Delta G^0 = -nFE$; $\Delta G^0 = -RT \ln(k)$; $E = E^0 - RT \ln Q$; Coulomb = ampere x seconds.). Pts = 106.

ESSAY. Write your answer in the space provided or on a separate sheet of paper.

1) Given $Cl_2 (g) + 2 e^- \rightarrow 2 Cl^- (aq)$ $E^0 = +1.36$ V

$I_2 (s) + 2 e^- \rightarrow 2 I^- (aq)$ $E^0 = +0.54$ V

Determine if reaction $Cl_2 (g) + 2 I^- (aq) \rightarrow 2 Cl^- (aq) + I_2 (s)$ is spontaneous or not. Show the (i) cathode and (ii) anode reactions. (3 + 3 + 4 = 10 pts)

Of the two half rxns, reduction of Cl_2 to Cl^- has more ⊕ive value, indicating that rxn. would predominate. Hence

(i) cathode rxn. $Cl_2(g) + 2e^- \rightarrow 2Cl^-$ $\mathcal{E}^\circ_{red} = +1.36V$

(ii) Anode rxn. $2I^-(aq) \rightarrow I_2(s) + 2e^-$ $\mathcal{E}^\circ_{red} = 0.54V$

So the $\mathcal{E}^\circ_{cell} = \mathcal{E}^\circ_{red\,(Red^n\ part)} - \mathcal{E}^\circ_{red\,(oxd^n\ part)} = 1.36 - 0.54 = 0.82V$

Since $\mathcal{E}^\circ_{cell}$ is ⊕ive, the above rxn. is spontaneous.

2) Write which is mono, bi, tri, tetra or pentadentate among the following ligands (8 pts):

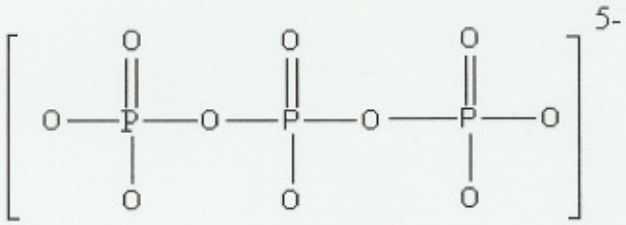
(a)

bidentate

(b) $(S{=}C{=}N)^-$

Monodentate

(c)



pentadentate

(d) CO_3^{2-}

bidentate

3) Given O_2 (g) + $4H^+$ (aq)+ $4e^-$ --> 2 H_2O (l) $E_{red}^0 = +1.23$ V

Ag^+ (aq) + e^- --> Ag (s) $E_{red}^0 = +0.80$ V

First show the (i) cathode and (ii) anode reactions and then calculate the (iii) standard free energy change and (iv) the equilibrium constant for the following reaction at 25° C. (3 + 3+ 4 + 8 = 18 pts)

$$4Ag\ (s) + O_2\ (g) + 4H^+\ (aq) \rightarrow 4\ Ag^+\ (aq) + 2\ H_2O\ (l)$$

The $\mathcal{E}^\circ_{red}$ potential being more ⊕ive of the reduction of O_2, that would be predominant, so

Cathode: $O_2(g) + 4H^+ + 4e^- \longrightarrow 2H_2O(l)$ $\mathcal{E}^\circ_{red} = 0.1.23V$

Anode: $4Ag(s) \longrightarrow 4Ag^+(aq) + 4e^-$ $\mathcal{E}^\circ_{red} = 0.8V$

$\mathcal{E}^\circ_{cell} = (1.23 - 0.8) = 0.43V$;

$\Delta G^\circ = -nF\mathcal{E}^\circ = -(4)(96485\ J/V.mol)(0.43V) = -170\ kJ/mol$

Also $\Delta G^\circ = -RT\ln K = -\dfrac{170,000\ J/mol}{1}$

$\ln K = \dfrac{-170,000\ J/mol}{-(8.314\ \frac{J}{mol.K}) \times 298K} = 69$

$K = 9 \times 10^{29}$

4) If the name is given, write the structure. If the structure is fgiven, then write the name of the following: (12 pts)

(a) [Ni $(NH_3)_6$] Br_2 Hexaaminenickel (II) bromide

(b) Aquacyanobis(ethylenediamine)cobalt(III) chloride $[Co(en)_2(H_2O)(CN)]Cl_2$

(c) $Na_2[MoOCl_4]$ Sodium tetrachloro oxo molybdate

MULTIPLE CHOICE. Choose the one alternative that best completes the statement or answers the question (4 pts each).

5) What is the oxidation number of chromium in $Cr_2O_7^{2-}$ ion ? 5) D

A) +3 B) +14 C) +7 D) +6 E) +12

6) Which one of the following reactions is a redox reaction? 6) E

A) $NaOH + HCl \rightarrow NaCl + H_2O$

B) $H_2O + NaCl \rightarrow NaOH + HCl$

C) $Pb^{2+} + 2Cl^- \rightarrow PbCl_2$

D) $AgNO_3 + HCl \rightarrow HNO_3 + AgCl$

E) None of the above is a redox reaction.

7) What is the coefficient of the permanganate ion when the following equation is balanced? 7) A

$MnO_4^- + Br^- \rightarrow Mn^{2+} + Br_2$ (acidic solution)

A) 2 B) 4 C) 5 D) 3 E) 1

8) One of the differences between a voltaic cell and an electrolytic cell is that in an electrolytic cell _____. 8) E

A) electrons flow toward the anode

B) O_2 gas is produced at the cathode

C) an electric current is produced by a chemical reaction

D) oxidation occurs at the cathode

E) a nonspontaneous reaction is forced to occur

9) Consider an electrochemical cell based on the reaction: 9) E

$2H^+ (aq) + Sn (s) \rightarrow Sn^{2+} (aq) + H_2 (g)$

Which of the following actions would change the measured cell potential?

A) increasing the pressure of hydrogen gas in the cathode compartment

B) increasing the pH in the cathode compartment

C) lowering the pH in the cathode compartment

D) increasing the $[Sn^{2+}]$ in the anode compartment

E) Any of the above will change the measure cell potential.

Table 20.2

Half-reaction	E° (V)
Cr^{3+} (aq) + $3e^-$ → Cr (s)	−0.74
Fe^{2+} (aq) + $2e^-$ → Fe (s)	−0.440
Fe^{3+} (aq) + e^- → Fe^{2+} (s)	+0.771
Sn^{4+} (aq) + $2e^-$ → Sn^{2+} (aq)	+0.154

10) The standard cell potential ($E°_{cell}$) for the voltaic cell based on the reaction below is _____ V. 10) A

$$Sn^{2+}\,(aq) + 2Fe^{3+}\,(aq) \rightarrow 2Fe^{2+}\,(aq) + Sn^{4+}\,(aq)$$

A) +0.617 B) +1.39 C) −0.46 D) +0.46 E) +1.21

11) What is the purpose of adding EDTA to prepared foods? 11) C

A) to complex iron(III) ions so they can catalyze protein decomposition on cooking

B) to prevent dissolution of the container in the food when stored for long periods of time

C) to complex trace metal ions that catalyze decomposition reactions

D) to keep ions such as Ca^{2+} in solution so the foods look good

E) to aid in browning of the surface during cooking

12) Formation of a complex species of M^{n+} metal ion with ligands often _____. 12) E

A) may cause changes in the ease with which M^{n+} is reduced or oxidized

B) reduces availability of the free M^{n+} ions in solution

C) alters original physical properties of M^{n+}

D) "masks" original chemical properties of both the M^{n+} ion and the ligands

E) all of the above

13) What are the respective central-metal oxidation state, coordination number, and overall charge on the complex ion in 13) C

$$Na_2[Cr(NH_3)_2\,(NCS)_4]?$$

A) +3; 6; +1 B) +3; 6; −1 C) +2; 6; −2 D) +1; 6; −2 E) +2; 4; −1

14) A complex of correctly written formula $[Pt(NH_3)_3Br]Br \cdot H_2O$ has which set of ligands in its inner coordination sphere? 14) D

A) 3 NH_3, 1 Br^--, and 1 H_2O

B) 3 NH_3, 2 Br^-, and 1 H_2O

C) 3 NH_3

D) 3 NH_3 and 1 Br^-

E) 3 NH_3 and 2 Br^-

15) The standard cell potential ($E°_{cell}$) for the reaction below is +0.63 V. The cell potential for this reaction is _____ V when $[Zn^{2+}] = 1.0$ M and $[Pb^{2+}] = 2.0 \times 10^{-4}$ M. 15) E

$$Pb^{2+}(aq) + Zn(s) \rightarrow Zn^{2+}(aq) + Pb(s)$$

A) 0.41 B) 0.63 C) 0.85 D) 0.74 E) 0.52

16) How many minutes will it take to plate out 2.19 g of chromium metal from a solution of Cr^{3+} using a current of 35.2 amps in an electrolyte cell _____ ? 16) B

A) 346 B) 5.77 C) 115 D) 1.92 E) 17.3

TRUE/FALSE. Write 'T' if the statement is true and 'F' if the statement is false (2 pts each).

17) When the cell potential is negative in a voltaic cell the cell reaction will not proceed spontaneously. 17) T

18) The electode where reduction occurs is called the anode. 18) F

19) The standard reduction potential, E^{o}_{red}, is proportional to the stoichiometric coefficient. 19) F

20) The standard reduction potential of X is 1.23 V and that of Y is –0.44 V therefore X is oxidized by Y. 20) F

21) If chloride is a ligand to a transition metal it will not be precipitated by silver nitrate. 21) T