Chemistry 233 Final Exam Review

Acids and Bases

1)Determine the pH of a solution that is 0.250 M in HCO_3^-

2)Determine the pH of a solution that is 0.125 M in CO_3^{2-}

3)What is the pH of 2.5 M KI in solution?

4)What is the conjugate acid of HPO_4^{2-}?

5)The Ksp of $BaSO_4$ is 1.5×10^{-9}. What is the molar concentration of $Ba^{2+}(aq)$ in a saturated solution of $BaSO4_4$?

6)Which of these acids is stronger? Electronegativity of X>Y>Z

H-O-X H-O-Y H-O-Z

7)Is a pH with a solution of 7.00 acidic, basic, or neutral for a neutral aqueous solution at 37 degrees C given that the Kw for water at this temperature if 2.4×10^{-14}?

8)Which is a stronger base? S^{2-} vs Se^{2-} and PO_4^{3-} vs AsO_4^{3-}

9)Are the following salts acidic, basic, or pH neutral?

NaF $CaBr_2$ K_2CO_3 $C_6H_5NH_3NO_2$

10)Determine whether the compound is more soluble in acidic solution of in pure water

CuS AgCl Hg_2Br_2 AgI $Mg(OH)_2$

11)What is the K_b for a 0.135M solution of weak base with a pH of 11.23?

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Titrations

1) Consider 25.0 ml of 0.100M $HCHO_2$ titrated with 0.150 M NaOH

a) Draw what a titration curve of this should look like and designate the relative pH at the equivalence point

b) Calculate the volume of titrant required to reach the equivalence point

c) Calculate the initial pH before any of the titrant is added

d) Calculate the pH after 5.00 mL of titrant is added

e) Calculate the pH at the half-equivalence point

f) Calculate the pH when 15.00 mL of titrant is added

g) For the volume in part f, what is the ratio of base to acid? Would this be an effective buffer?

h) Calculate the pH at the equivalence point

i)Calculate the pH after 20.00 mL of titrant is added

Coordination compounds

1) For the following coordination compounds, give the oxidation state and coordination number of the metal ion

$[Cr(H_2O)_6]^{3+}$ $[Co(NH_3)_3Cl]^{-}$ $Cl[M(CN)_4]^{2-}$ $[Co(NH_3)_5Br]^{2+}$ $Na[M(ox)_3]^{4-}$

Here is a following key for identifying isomers:

Cis-Trans (can occur in octahedral and tetrahedral/square planar structures)

Must contain exactly two monodentate ligands of the same kind bonded to the metal

Fac-mer (only occurs in octahedral)

Must contain exactly three monodentate ligands of the same kind bonded to the metal

Coordination (octahedral and tetrahedral/square planar)

Can only occur when an ion bonded to the metal and an ion of the same charge not directly bonded are present. Ex: $Na[M(Cl)_2BrK)$ because K^+ and Na^+ can interchange

Linkage (octahedral and tetrahedral/square planar)

When a ligand that has more than one possible electron regions (bonding site ie electron pairs) are present Ex: CN, SCN, NO_2 can bind to more than one atom to the central metal

Optical (only in octahedral)

Three bidentate ligands bonded to the central metal. Bidentate are (ox) and (en)

2)Provide all the isomers for the following coordination compounds:

$[Cr(en)_2Cl_2]^+$

$[Cr(H_2O)_2(NH_3)_3Cl_2]^+$

$Na[M(H_2O)_2(CN)_2]$

$Na[M(CO)_3Cl_3]$

$[Cr(NH_3)_2(ox)_2]^-$

$[Cr(CO)_6]^+$

$Br[M(CO)_2(H_2O)Cl]^+$

$[Pt(NH_3)Cl_3]^-$

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Free Energy and Thermodynamics

1)Consider the reaction: $I_{2(g)} + Cl_{2(g)} \rightleftharpoons 2ICl_{(g)}$ $K_p = 8.91$ at 25 deg c

a) Calculate ΔG_{rxn} for the reaction at 25 deg C under:

Standard condition

b) At equilibrium

c) $P(Cl_2) = 2.55$ atm; $P(I_2) = 0.325$ atm; $P(Cl_2) = 0.221$ atm

2)What is the cross over temperature for the reaction?

$$3H_2(g) + Fe_2O_3(s) \rightarrow 2\ Fe\ (s) + 3\ H_2O\ (g)$$

3)At 25 degrees C, calculate the free energy change for the reaction. Is it spontaneous?

$2Ca_{(s)} + O_{2(g)} \rightarrow 2CaO_{(s)}$ $\Delta H_{rxn} = -1269.8$ kJ

4) Fill in the table

ΔH	ΔS	ΔG	Low temperature	High temperature
-	+	-	Spontaneous	
+	-	Temperature dependent		
+	+	-		Spontaneous
	-		Non-spontaneous	Non-spontaneous

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Electrochemistry

1a) Balance the redox reaction in acidic aqueous solution: $NO_3^-{}_{(aq)} + Sn^{2+}{}_{(aq)} \rightarrow Sn^{4+}{}_{(aq)} + NO_{(g)}$

1b) Balance the redox reaction in basic aqueous solution: $NO_2^-{}_{(aq)} + Al_{(s)} \rightarrow NH_{3(g)} + AlO_2^-{}_{(aq)}$

2)Which metal is the best oxidizing agent?

Pb^{2+} Cr^{3+} Fe^{2+} Sn^{2+}

3)Which metal is the best reducing agent?

Mn Al Ni Cr

4) Rank in terms of increasing strength of reducing agent: Na, Fe, Ag, Sn

5) Will Nickel dissolve in HCl?

6) What are the anode and cathode reactions for the electrolysis of aqueous PbI_2?

7) What is the standard cell potential for the reaction: $2Ag^+{}_{(aq)} + Pb_{(s)} \rightarrow 2Ag_{(s)} + Pb^{2+}{}_{(aq)}$ is it spontaneous?

8) What is the spontaneity of the following reaction at 25 deg C?

$Pb^{2+}{}_{(aq)} + Mg_{(s)} \rightarrow Pb_{(s)} + Mg^{2+}{}_{(aq)}$

9) What is the value of the equilibrium constant for the reaction between Fe^{2+} and $Zn_{(s)}$ at 25 deg C?

10) What mass of aluminum metal can be produced per hour in the electrolysis of molten aluminum salt by a current of 25 A?

11) Sodium oxalate, $Na_2C_2O_4$, in aqueous solution and under acidic conditions is oxidized to $CO_{2(g)}$ by MnO_4^-, which is reduced to Mn^{2+}. If it takes 45.1 mL of a 0.250 M solution of MnO_4^- to titrate a 25.00 mL sample of an aqueous solution of sodium oxalate, what is the molarity of the sodium oxalate solution?

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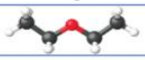
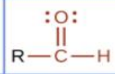
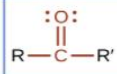
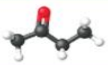
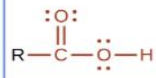
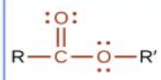
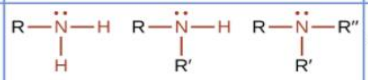
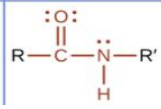
Organic Chemistry

Compound Name	Structure of Compound and Functional Group (red)	Example	
		Formula	Name
alkene	C=C	C_2H_4 	ethene
alkyne	C≡C	C_2H_2 	ethyne
alcohol	R—O—H	CH_3CH_2OH 	ethanol
ether	R—O—R′	$(C_2H_5)_2O$ 	diethyl ether
aldehyde		CH_3CHO 	ethanal
ketone		$CH_3COCH_2CH_3$ 	methyl ethyl ketone
carboxylic acid		CH_3COOH 	acetic acid
ester		$CH_3CO_2CH_2CH_3$ 	ethyl acetate
amine		$C_2H_5NH_2$ 	ethylamine
amine		CH_3CONH_2 	acetamide

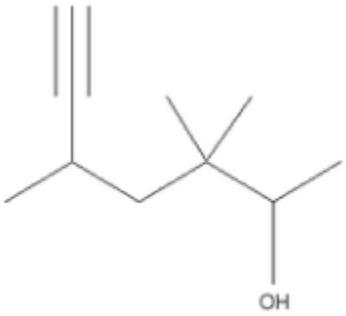
Draw (on a separate sheet)

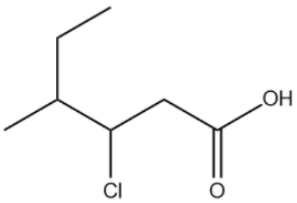
2,3,-dimethylbutane 3,3-dimethyl-1-pentyne 4-heptanone ethyl propyl ether

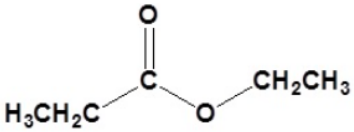
3-ethylhaptanoic acid 3-isopropylheptane 3-ethyl-1-hexanol butyl ethanoate

4-ethyl-2,2-dimethylhexane 2-methylbutanal pentanoic acid dipentyl ether

Name the following:







The hydrogenation of 2-methyl-3-butene yield what products?