# Chem 130 – Third Exam

Name________________________________

On the following pages you will find eight questions covering varies topics ranging from precipitation–solubility, acid–base, and oxidation–reduction reactions to metal–ligand complexes and coordination compounds. Read each question carefully and consider how you will approach it before you put pen or pencil to paper. If you are unsure how to answer a question, move to another; working on a new question may suggest an approach to the one that is more troublesome. If a question requires a written response, be sure that you answer in complete sentences and that you directly and clearly address the question.

Partial credit is willingly given on all problems so be sure to answer all questions!

| | |
|---|---|
| Question 1 _____/16 | Question 5 _____/12 |
| Question 2 _____/14 | Question 6 _____/12 |
| Question 3 _____/16 | Question 7 _____/8 |
| Question 4 _____/6 | Question 8 _____/16 |

Total _____/100

Potentially useful equations and constants:

$$c = \lambda\nu \qquad E = h\nu \;\bullet\; hc/\lambda$$

$$KE = h\nu - W \qquad \frac{1}{\lambda} = 1.09737\times10^{-2}\ \text{nm}\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

$$FC_a = V_a - N_a - \frac{B_a}{2} \qquad V \propto \frac{Q_+Q_-}{d}$$

$$AVEE = \frac{xIE_s + yIE_p + zIE_d}{x+y+z} \text{ (valence shell electrons only)}$$

$$\delta_a = V_a - N_a - B_a\left(\frac{EN_a}{EN_a + EN_b}\right) \qquad c = 2.998\times10^8\ \text{m/s}$$

$$h = 6.626\times10^{-34}\ \text{Js} \qquad N_A = 6.022\times10^{23}\ \text{mol}^{-1}$$

Other potentially useful information is available as separate handouts.

**Problem 1**. For each pair of acids, circle the one that is stronger and in no more than two sentences explain your reason for this choice. The acidic proton in each compound is underlined.

(a) $\underline{H}_2S$ vs. $\underline{H}_2Te$

(b) $ClH_2CCOO\underline{H}$ vs. $FH_2CCOO\underline{H}$

(c) $\underline{H}ClO$ vs. $\underline{H}ClO_2$

(d) $H_2SO_3$ vs. $HSO_3^-$

**Problem 2**. The metals A, B, C, and D have the following properties:

(a) all four metals dissolve in $HNO_3$, forming +2 cations and releasing NO*(g)*

(b) A and C, but not B and D, dissolve in HCl, releasing $H_2$*(g)*

(c) adding C to an aqueous solution containing $A^{2+}$, $B^{2+}$, or $D^{2+}$ results in the formation of A*(s)*, B*(s)*, or D*(s)*

(d) D undergoes oxidation in the presence of $B^{2+}$

Based on these observations, rank the redox couples

$$A^{2+}/A \qquad B^{2+}/B \qquad C^{2+}/C \qquad D^{2+}/D \qquad H^+/H_2 \qquad NO_3^-/NO$$

from the strongest oxidizing agent to the weakest oxidizing agent. Explain the reason for your rankings in no more than five sentences.

strongest oxidizing agent

1.
2.
3.
4.
5.
6.

weakest oxidizing agent

**Problem 3**. The table below has rows containing cations and columns containing anions. For each possible combination of cation and anion, determine if a precipitate will form when a solution of the anion is added to a solution of the cation. If a precipitate forms, then enter the precipitate's chemical formula. If a precipitate does not form, then write no reaction (NR) in the corresponding cell.

| | $Cl^-$ | $OH^-$ | $NO_3^-$ | $PO_4^{3-}$ |
|---|---|---|---|---|
| $K^+$ | | | | |
| $Fe^{3+}$ | | | | |
| $Ca^{2+}$ | | | | |
| $Ag^+$ | | | | |

**Problem 4**. Moving between a coordination compound's name and its formula is an important skill. With that in mind, what is the name for $Na_3[AlF_6]$?

What is the formula for diamminetriaquahydroxochromium(III) nitrate?

**Problem 5**. When discussing coordination compounds we describe the metal in terms of its ordinary valency and its coordination valency. Using $[Cr(en)_3]Cl_3$ and $K_4[CrF_6]$ as examples, and in no more than six sentences, explain the difference between these two valencies. As part of your answer, be sure to clearly state the values for chromium's two valencies in each compound and how you determined their values. Note that "en" is the bidentate ligand ethylenediamine, which has the structure $H_2NCH_2CH_2NH_2$.

**Problem 6**. Of the two complex ions $[Co(NH_3)_6]^{3+}$ and $[CoF_6]^{3-}$, one is paramagnetic and one is diamagnetic. In 4–6 sentences, explain why this is possible.

Of the two complexes, $[CoF_6]^{3-}$ is green and $[Co(NH_3)_6]^{3+}$ is yellow-orange. Identify the complex that is paramagnetic (circle your choice) and, in 2–4 sentences, explain your reasoning.

$[Co(NH_3)_6]^{3+}$ $[CoF_6]^{3-}$

**Problem 7**. There are two isomers of the compound having an empirical formula of $Co(NH_3)_5SO_4Br$. When dissolved in water, one isomer forms a white precipitate upon adding $BaCl_2$ or $AgNO_3$; the other isomer forms a white precipitate upon adding $AgNO_3$, but does not form a precipitate with $BaCl_2$. In 2–4 sentences, provide an explanation for these observations. As part of your answer, provide the structural formulas for each compound.

**Problem 8.** Consider the hypothetical metal-ligand complex $MABC_3D$, where M is a metal ion and A, B, C, and D are ligands. Draw all possible geometric isomers for this octahedral metal-ligand complex. Do not consider optical isomers. Be careful to draw only once each unique geometric isomer. There are more spaces than unique geometric isomers!

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