Chem 130 – Third Exam

Name_____

On the following pages you will find questions covering various topics ranging from the structure of solid-state materials, the chemistry of acid-base and oxidation-reduction reactions, and metal-ligand complexes. Read each question carefully and consider how you might approach the problem before you put pen or pencil to paper. If you aren't sure how to start a question, move to another problem; working on a new question may suggest an approach to that more troublesome problem. For problems requiring a written response, be sure that your answer is written in complete sentences and that it directly and clearly answers the question.

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

Question 1 _____/20	Question 5 _____/6
Question 2 _____/14	Question 6 _____/18
Question 3 _____/12	Question 7 _____/18
Question 4 _____/12	

Total _____

Potentially useful equations and constants:

$c = \lambda\nu$ $\quad E = h\nu$ $\quad KE = h\nu - BE$ $\quad \frac{1}{\lambda} = 1.09737\times10^{-2}\ \text{nm}\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$ $\quad V = \frac{kq_1q_2}{d}$

$$FC_a = V_a - N_a - \frac{B_a}{2} \quad \delta_a = V_a - N_a - B_a\left(\frac{EN_a}{EN_a + EN_b}\right)$$

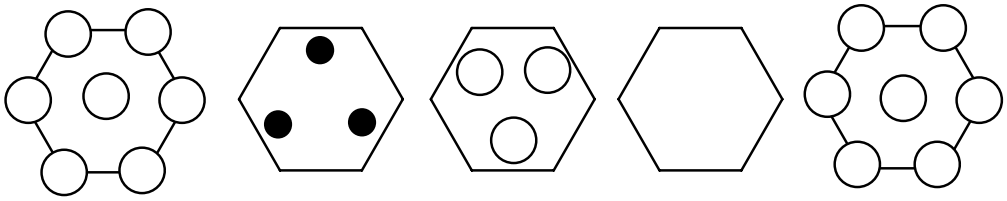
$$OX_a = V_a - N_a - B_a \times (0 \text{ if least EN}; 1 \text{ if most EN})$$

$c = 2.998\times10^{8}$ m/s $\quad h = 6.626\times10^{-34}$ Js $\quad N_A = 6.022\times10^{23}$ mol^{-1}

$K_a \times K_b = K_w$ for conjugate acid/base pair

Some potentially useful tables are on an additional handout.

Question 1. Shown below are five cross-sections through the unit cell an ionic solid. Anions are shown as open circles (○) and cations are shown as solid circles (●).



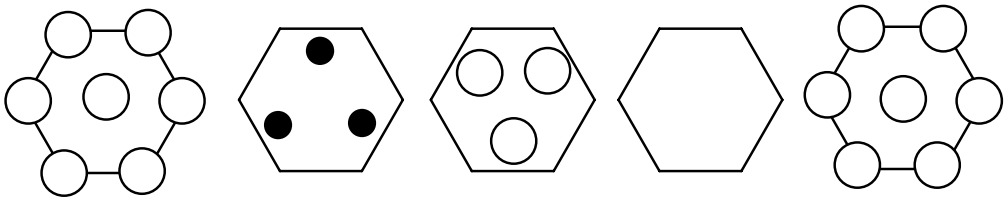
How many anions are in this unit cell? Clearly show how you arrived at this answer by *labeling above each anion with its contribution to the unit cell*.

How many cations are in this unit cell? Clearly show how you arrived at this answer by *labeling above each cation with its contribution to the unit cell*.

If each anion has a charge of -1, what is the charge on each cation? Clearly explain your answer in one sentence.

In what type of hole does each cation sit and what percentage of these holes contain cations?

In addition to the holes occupied by cations, there is another type of hole in the anion's lattice. What type of hole is this? Place an **X** in a one of the layers shown below such that it clearly marks one of these holes. In addition, shade the anions coordinated to this hole.



Question 2. Consider the following three acids. Place an **S** below the strongest of the acids and a **W** below the weakest of the acids. Briefly explain your reasoning in two or three sentences. In your answer, be sure to provide a chemically relevant reason for your rankings.

H_2Se H_2S HF

Consider the following three bases. Place an **S** below the strongest of the bases and a **W** below the weakest of the bases. Briefly explain your reasoning in two or three sentences. In your answer, be sure to provide a chemically relevant reason for your rankings.

BrO_2^- BrO^- ClO_2^-

Question 3. Ammonium acetate is an interesting compound because it contains both a weak acid, NH_4^+, and a weak base, CH_3COO^-. When $NH_4CH_3COO(s)$ dissolves in water the following acid-base reaction may occur:

$$NH_4^+(aq) + CH_3COO^-(aq) \leftrightarrows NH_3(aq) + CH_3COOH(aq)$$

Will the resulting solution contain more NH_4^+ or more NH_3? The K_a for CH_3COOH and the K_b for NH_3 are each 1.75×10^{-5}. In one to three sentences, provide a convincing explanation for your choice. You may supplement your answer with a calculation, but it is not necessary to do so! A calculation without an accompanying written explanation will receive little partial credit.

Question 4. Metals such as Au and Pt are very unreactive, which is one reason why they are valuable. In 800 AD the Islamic alchemist Jabir Ibn Hayyan discovered that Pt, which does not dissolve in HCl or in HNO_3, will dissolve in a mixture of these acids. This mixture is more commonly known as *aqua regia*. Given the following standard state reduction potentials

$Pt^{2+}(aq) + 2e^- \rightarrow Pt(s)$	$E^o = 1.188$ V
$HNO_3(aq) + 3H^+(aq) + 3e^- \rightarrow NO(g) + 2H_2O(l)$	$E^o = 0.96$ V
$PtCl_4^{2-}(aq) + 2e^- \rightarrow Pt(s) + 4Cl^-(aq)$	$E^o = 0.755$ V
$2HCl(aq) + 2e^- \rightarrow H_2 + 2Cl^-(g)$	$E^o = 0.00$ V

write the reaction showing how Pt dissolves in *aqua regia*.

In one to three sentences, provide a convincing explanation for your choice. You may supplement your answer with a calculation, but it is not necessary to do so! A calculation without an accompanying written explanation will receive little partial credit.

For your reaction, what is the oxidizing agent and what is the specific change in oxidation state that is occurring?

Question 5. Provide the name for the coordination compound $(NH_4)_4[Fe(ox)_3]$ where "ox" is the oxalate anion, $C_2O_4^{2-}$.

Provide the chemical formula for the coordination compound

hexaminecobalt(III) pentachlorocuprate(II)

Question 6. The table below contains data for a series of coordination compounds. Fill in the missing blanks. If you wish, use the boxes below the table to annotate you work.

	Empirical Formula	# ions	# Cl^- ppt as AgCl	Oxidation State for Pt	Coordination Number for Pt	Chemical Formula
a	$PtCl_4 \bullet 6NH_3$					$[Pt(NH_3)_6]Cl_4$
b	$PtCl_4 \bullet 4NH_3$	3	2			
c	$PtCl_4 \bullet 2NH_3$	0		+4		
d	$PtCl_4 \bullet 2KCl$	3			6	
e	$PtCl_2 \bullet NH_3 \bullet KCl$		0	+2		
f	$2PtCl_2 \bullet 4NH_3$	2	0	+2/+2	4/4	

a.	b.	c.
d.	e.	f.

Question 7. The ligand nitrite may bind either through its nitrogen ($-NO_2^-$) or through one of its oxygens ($-ONO^-$). In the boxes below, draw all possible geometric and linkage isomers for the octahedral coordination compound $Pt(NH_3)_2(NO_2)Cl_3$. Do not include optical isomers in your answers. Be careful to draw each unique isomer only once. There may be more spaces than answers! Use the back of your this page for your initial work and places your answers only here. Please note that I will not be evaluating work on the back side of this page.
