

## How was Experiment 5 Graded?

Chem 151 Fall 2009

### III.A. Ligand Substitution Reaction of Fe(III) complexes (18 pts. possible)

2 points were awarded for each correct answer in Lines 1 and 2.

6 points were awarded for the three correct answers in Lines 3.

*Note that the name of the ligand  $\text{SCN}^-$  is thiocyanato because the anion is called thiocyanate. Since ligand substitution occurs in steps, any three complexes of the six possibilities are acceptable. However, when there are more than three  $\text{SCN}^-$  ligands surrounding  $\text{Fe}^{3+}$ , the complex becomes an anion and shall be named as ferrate(III) instead of iron(III).*

2 points were awarded for each correct answer in Lines 4 and 5.

$$\text{Moles of } \text{SCN}^- \text{ added} = (0.05 \times 10^{-3} \text{ L})(2.5 \text{ mol/L}) = 1.25 \times 10^{-4} \text{ mol}$$

$$\text{Moles of EDTA added} = (1 \times 10^{-3} \text{ L})(0.125 \text{ mol/L}) = 1.25 \times 10^{-4} \text{ mol}$$

4 points were awarded for the correct ranking of the ligands.

### III.B. Complex Formation and Ligand Substitution of Copper(II)... (18 points possible)

4 points were awarded for each of Questions 8 → 11

- Upon dissolving  $\text{CuSO}_4$  in water, the major complex ion in solution of Step 8 is:  $\text{Cu}(\text{H}_2\text{O})_6^{2+}$ , hexaaquacopper(II).
- The precipitate is:  $\text{Cu}(\text{OH})_2$ , copper(II) hydroxide.
- Upon addition of  $\text{NaOH}$ , the complex ion in solution can be:  $\text{Cu}(\text{H}_2\text{O})_3(\text{OH})_3^-$  or  $\text{Cu}(\text{H}_2\text{O})_2(\text{OH})_4^{2-}$ , but not  $\text{Cu}(\text{H}_2\text{O})_3(\text{OH})^+$  or  $\text{Cu}(\text{H}_2\text{O})_4(\text{OH})_2$ .
- Upon addition of  $\text{NH}_3$ , the complex ion in solution can be:  $\text{Cu}(\text{H}_2\text{O})_{6-n}(\text{NH}_3)_n^{2+}$  where  $n$  can be from 0 → 4.
- The major complex formed in Step 13 is:  $\text{Cu}(\text{EDTA})^{2-}$  Ethylenediaminetetraacetatocuprate(II). Here, we assumed that the strong chelating agent EDTA substitutes all ligands (including the two solvents ligands) on the octahedral complex. However, another acceptable answer is Diaquaethylenediaminetetraacetatocuprate(II).

2 points were awarded for Questions 12. *One can use a spectrophotometer to take an absorption spectrum of each solution and make comparison.*

### III.C. The 6-Coordinate and 4-Coordinate Complexes of Cobalt(II)

4 pts. were awarded for each correct calculation of Lines 16 and 17. (8 points possible)

*Supposed the mass of  $\text{CoCl}_2 \cdot 6\text{H}_2\text{O}$  in the weigh-boat is 0.0500 g,*

$$\text{Moles of } \text{CoCl}_2 = \frac{0.0500 \text{ g}}{237.63 \text{ g/mol}} = 2.10 \times 10^{-4} \text{ mol}$$

$$\text{Molarity of } \text{CoCl}_2 \text{ in } 5.0 \text{ mL solution} = \frac{2.10 \times 10^{-4} \text{ mol}}{0.0050 \text{ L}} = 4.2 \times 10^{-2} \text{ mol/L}$$

$$\text{molarity of } \text{CoCl}_2 \text{ in the cuvette is: } (0.042 \text{ M}) \left( \frac{0.5 \text{ mL}}{2.0 \text{ mL}} \right) = 0.01 \text{ M}$$

4 pts. were awarded for each correct response in Lines 18 → 22. (16 points possible)

The color of the  $\text{Co}(\text{H}_2\text{O})_6^{2+}$  complex is pink and has  $\lambda_{\text{max}}$  at  $512 \pm 5$  nm.

The color of the  $\text{Co}(\text{SCN})_4^{2-}$  complex is blue and has  $\lambda_{\text{max}}$  at  $612 \pm 5$  nm.  
*purple color is not acceptable*

## INTRODUCTION TO COORDINATION CHEMISTRY

3. In the boxes below, enter the oxidation number of the central metal in each complex.



+2



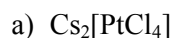
+2



+2

2 pts. possible.  
Deduct one point  
was deducted for  
each mistake not to  
exceed 2 total

4. Read "Naming of Coordination Compounds" (an additional link in Tutorial Reading #1), practice on the examples, and name the following coordination compounds.

*Cesium tetrachloroplatinate(II)**Tetraamminedichlorocobalt(III) bromide**Pentaaquathiocyanatoiron(III)*

4 pts. possible.  
One point was  
deducted for  
each mistake  
not to exceed 4  
total points.

5. Calculate the mass of  $\text{CuSO}_4 \cdot 5\text{H}_2\text{O}$  needed for preparing 4 mL of 0.04 M  $\text{CuSO}_4$  solution. Enter your answer in the box and show your work in the space below.

0.04 g.

1 pt.

$$\text{Mass of } \text{CuSO}_4 \cdot 5\text{H}_2\text{O} = (0.04 \text{ mol/L})(0.004 \text{ L})(249.5 \text{ g/mol}) = 0.04 \text{ g}$$