

Chemistry 116: Laboratory Homework
Experiment 9 & 10: Groups II-III Qualitative Analysis

Student Name: _____ Lab Room No. _____ Desk No. _____
Lab Day _____ Lab Start Time _____ Date _____

Directions: Answer the following questions. For numerical answers a) show all work to support your final numerical answer(s), b) include correct units and significant figures, and c) circle your final numerical answer. Answer non-numerical questions by a) answering the question, b) fully explaining, and c) using complete sentences.

1. A solution is saturated with H_2S at a concentration of 0.10 M and is 4.0×10^{-5} M in each of the metal cations Co^{+2} , Fe^{+2} , Mn^{+2} , Ni^{+2} , and Zn^{+2} . At a pH of 4.0, which of the metal cations will precipitate as the sulfide? Explain. (HINT: Calculate IP.)

<u>Metal Sulfide</u>	<u>K_{spA}</u>
ZnS	3×10^{-2}
NiS	0.80
CoS	3
FeS	6×10^2
MnS	3×10^{10}

2. Under the conditions given in the preceding question, what pH is needed to precipitate as much of the Zn^{+2} and Ni^{+2} as possible without precipitating the Co^{+2} , Fe^{+2} and Mn^{+2} ?
3. Under the conditions given in the first question, at what pH will the FeS first begin to precipitate from solution?

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4. An aqueous solution contains the metal cations Hg^{+2} and Mn^{+2} belonging to Groups II and III, respectively. Thioacetamide, which produces H_2S , is added, and the solution is buffered to a pH of 8 by addition of $\text{NH}_3/\text{NH}_4\text{Cl}$.
- Under these Group III conditions, what compounds will precipitate from solution?
 - If Group II conditions are imposed by lowering the solution pH to 1, what compound(s) (if any) will remain precipitated?
5. A solution is 0.0016 M in each of the metal cations Mn^{+2} and Cu^{+2} .
(MnS : $K_{\text{spA}} = 3 \times 10^{10}$; CuS : $K_{\text{spA}} = 6 \times 10^{-16}$)
- Enough thioacetamide and HCl are added to give the following equilibrium concentrations: $[\text{H}_2\text{S}]_{\text{eq}} = 0.1 \text{ M}$ and $[\text{H}_3\text{O}^+] = 6 \text{ M}$. Calculate the concentrations of Mn^{+2} and Cu^{+2} which remain in solution under these Group II conditions.
 - Under these Group II conditions, have the cations (Mn^{+2} or Cu^{+2}) been almost totally removed from solution by precipitation? Explain.
 - Enough $\text{NH}_3/\text{NH}_4\text{Cl}$ buffer is added to give the following equilibrium conditions: $[\text{NH}_3]_{\text{eq}} = 2.0 \text{ M}$, $[\text{NH}_4\text{Cl}]_{\text{eq}} = 0.10 \text{ M}$, and $[\text{H}_2\text{S}]_{\text{eq}} = 0.016 \text{ M}$. Calculate the concentrations of Cu^{+2} and Mn^{+2} which remain in solution under these Group III conditions.
(NH_3 : $K_{\text{B}} = 1.8 \times 10^{-5}$)
HINT: First calculate the pH and $[\text{H}_3\text{O}^+]$ of the buffered solution.
 - Under these Group III conditions, have the cations (Mn^{+2} or Cu^{+2}) been almost totally removed from solution by precipitation? Explain.