**Cation III-Practice**

1. For the following, write a procedure that will separate/identify if either or both are present or absent. **There are no other cations present.** Write net-ionic equations and observations. *NOTE: Do not write unnecessary procedures and reactions.* They will be counted incorrect. **NOTE: Do not write a flow chart as your answer**
   a. CrO$_4^{2-}$ and Al(OH)$_4^{-}$

2. For the following pairs of cations only one is definitely present. Give a **single** reagent/single step and observations that will separate the following cations. In addition to the single reagent you may use an acid, base, or heat. Write the corresponding net-ionic equations.
   a. Ni$^{2+}$ and Al$^{3+}$

3. For the following, write a procedure that will separate/identify if either or both are present or absent. Write net-ionic equations and observations. **Other Cations may be present.** *NOTE: Do not write unnecessary procedures and reactions.* They will be counted incorrect. **NOTE: Do not write a flow chart as your answer!!**
   Fe$^{3+}$, Al$^{3+}$

4. An unknown may contain one or more from the Cation III group, but no other cations groups may be present. After studying the procedure and observations, **Give those cations which are present, absent, and those whose presence is questionable.** **Give reasons and confirmation reaction equations for your conclusions on the next page.**

<table>
<thead>
<tr>
<th>Procedure</th>
<th>Observations</th>
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<tbody>
<tr>
<td>1. The pH was adjusted with NaOH to 8 with universal indicator paper. Then, an excess amount of NaOH was added. H$_2$O$_2$ was added and the sample was mixed heated and centrifuged. The supernatant was transferred to another test tube (see step 5), and the ppt was washed-see step 2</td>
<td>Black ppt formed</td>
</tr>
</tbody>
</table>
| 2. **PPT from step 1**
   a. HNO$_3$ and HCl was added. | ppt dissolved |
   b. NH$_3$ was added until the soln was basic. An excess amount of NH$_3$ was added. | A dark brown ppt formed |
   c. The ppt was washed, centrifuged (see step 4), and the supernatant was transferred to another test tube – see step 3 |
| 3. **Supernatant from step 2**
   Dil acetic acid was added to the supernatant until the soln was acidic. NH$_3$ and DMG was added. | A tan colored supernatant formed. |
| 4. **PPT from step 2**
   The ppt was divided into two parts-1/3 and 2/3 | The mixture was a light brown color |
   a. HNO$_3$ and NaBiO$_3$ was added to the 2/3 part. | A deep blue ppt formed |
   b. HCl and heat was added to the 1/3 part. The resulting solution was divided into two equal parts:
      (1) To the first part-> K$_4$Fe(CN)$_6$ was added | A deep red solution formed |
      (2) To the second part-> KSCN was added |
| 5. **Supernatant from step 1**
   a. 6 M HNO$_3$ was added until the solution was acidic. NH$_3$ was added until the solution was basic, then an excess amount was added. The mixture was heated, centrifuged and the supernatant was transferred into another test tube | A white gelatinous ppt formed. |
| 6. **PPT from step 5**
   a. The precipitate was washed and then 6 M HNO$_3$ was added. | The white gelatinous ppt dissolved |
   b. Aluminon was added and then 6 M NH$_3$ until slightly basic. | A cherry red “lake” precipitate was produced |
<table>
<thead>
<tr>
<th><strong>7. Supernatant from step 5</strong></th>
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<tr>
<td>b. The supernatant was acidified with acetic acid and a small amount of sodium acetate was added. BaCl$_2$ was added.</td>
<td>A white ppt formed</td>
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<tr>
<td>c. The precipitate was washed. 2 drops of 6 M HNO$_3$, was added, followed by 10 drops of DI water. In the hood, 10 drops of ether and 1 drop of 3% H$_2$O$_2$ was added.</td>
<td>PPT dissolved</td>
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<tr>
<td><strong>Supernatant is divided in 1/2</strong></td>
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<tr>
<td>d. To the the first 1⁄2 of the supernatant, 3 drops of dithizone (phenylthiocarbazone) was added.</td>
<td>A grayish color formed</td>
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<tr>
<td>e. With the remainder 1⁄2 of the supernatant, 6 M HCl was added until acidic, followed by the addition of 3 drops of 0.3 M K$_4$Fe(CN)$_6$.</td>
<td>A small amount of orange ppt formed</td>
</tr>
</tbody>
</table>
Give those cations which are present, absent, and those whose presence is questionable. Give reasons and the confirmation reaction equation for each of your conclusions.

Ni is questionable. A tan colored supernatant was formed and there was no mention of an orange-red ppt forming when DMG was added in step 3

→ (No eqn needed here b/c Ni is questionable)
Cation III Separation Reactions

\[ \text{H}_2\text{O}_2 + \text{Mn(OH)}_2 + \text{H}_2\text{O} \longrightarrow \text{MnO}_2 + \text{OH}^- \] (unbalanced)

\[ \text{Cr(OH)}_4^- + \text{H}_2\text{O}_2 + \text{H}_2\text{O} \longrightarrow \text{CrO}_4^{2-} + \text{OH}^- \] (unbalanced)

\[ 2\text{H}_3\text{O}^+ + 2\text{CrO}_4^{2-} \rightleftharpoons \text{Cr}_2\text{O}_7^{2-} + 3\text{H}_2\text{O} \]

\[ \text{Co}^{3+} + 3\text{SCN}^- + 3[\text{O=C(CH}_3)_2] \longrightarrow \text{Co(SCN)}_3[\text{O=C(CH}_3)_3]_3 \]

\[ \text{Ni(NH}_3)_6^{2+} + 2(\text{CH}_3)_2\text{C}_2(\text{NOH})_2 \longrightarrow 2\text{NH}_4^+ + \text{NiC}_8\text{H}_14\text{N}_4\text{O}_4 + 4\text{NH}_3 \]

\[ 2\text{MnO}_2 + 3\text{BiO}_3^- + 10\text{H}^+ \longrightarrow 2\text{MnO}_4^- + 3\text{Bi}^{3+} + 5\text{H}_2\text{O} \]

\[ 4\text{Fe}^{3+} + 3\text{Fe(CN)}_6^{4-} \longrightarrow \text{Fe}_4[\text{Fe(CN)}_6]_3 \]

\[ \text{Fe}^{3+} + 5\text{H}_2\text{O} + \text{SCN}^- \longrightarrow \text{Fe(H}_2\text{O)}_5\text{SCN}^{2+} \]

\[ 2\text{H}_3\text{O}^+ + 2\text{CrO}_4^{2-} \rightleftharpoons \text{Cr}_2\text{O}_7^{2-} + 3\text{H}_2\text{O} \]

\[ 4\text{H}_2\text{O}_2 + \text{Cr}_2\text{O}_7^{2-} + 2\text{H}_2\text{O}^+ \rightleftharpoons 5\text{H}_2\text{O} + 2\text{CrO}_5 \]

\[ \text{DPTC} + \text{Zn}^{2+} \longrightarrow \text{Zn-DPTC} \]

*Note: DPTC is Diphenyliothiocarbazone/Dithizone

\[ 3\text{Zn}^{2+} + \text{K}_4[\text{Fe(CN)}_6] \longrightarrow \text{Zn}_3\text{K}_2[\text{Fe(CN)}_6]_2 \]