

$$26,5 + 0,5 = \frac{27}{30}$$



Chemistry 205 Report

Qualitative Analysis



Date: 27/4/2012

Section: _____

Purpose: studying qualitative methods of separating cations from one another in a mixture, developing a procedure for separating ~~the~~ some ions, and finally separating & identifying a mixture of group I ions - Ag^+ & Pb^{2+} & Hg_2^{2+} in a known & unknown mixture.

Part I: Qualitative Analysis

Table 1. Preliminary Procedure (observations)

Record your observations and write the structure of the product in the proper box.

| Cation | NaOH | NaCl | Thioacetamide | NH ₃ |
|-------------------------------|---|--|--|---|
| Ag ⁺ | greyish brown ppt (AgOH) | white ppt (AgCl) | light grey (Ag ₂ S) | black ppt clear Ag(NH ₃) ⁺ |
| Pb ²⁺ | cloudy / turbid white Pb(OH) ₂ | PbCl ₂ white ppt | dark (PbS) grey | white ppt Pb(OH) ₂ |
| Hg ₂ ²⁺ | white ppt yellow Hg(OH) ₂ | white ppt white HgCl ₂ | greenish (Hg ₂ S) yellow | grey ppt Hg ₂ (OH) ₂ |
| Hg ²⁺ | no yellow / Hg(OH) ₂ | white ppt HgCl ₂ | brown & HgS | white ppt Hg(OH) ₂ |
| Cu ²⁺ | cloudy Cu(OH) ₂ blue ppt | - | Dark CuS green | dark blue Cu(NH ₃) ₄ ²⁺ Cu(OH) ₂ |
| Al ³⁺ | Al(OH)₃ white ppt | - | white ppt Al(OH) ₃ | white ppt Al(OH) ₃ |
| Fe ³⁺ | Fe(OH) ₃ brown ppt | - | w/ turbid FeS light brown ppt | red ppt Fe(OH) ₃ |
| Mg ²⁺ | Mg(OH) ₂ white ppt | - | - | - |
| Ca ²⁺ | Ca(OH) ₂ white | - | - | - |
| Na ⁺ | - | - | - | - |
| K ⁺ | - | - | light yellow ppt | - |
| NH ₄ ⁺ | - | - | light brown ppt | - |

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Part II: Analysis of Group I cations

Table 2. Analysis of Group I ions (Known)

| Reagent | Observation | Conclusion |
|--------------------------|--|--|
| 6 M HCl | white ppt | Carbon for GP I (Ag^+ , Pb^{2+} , Hg^+) |
| K_2CrO_4 | yellow ppt in Pb^{2+} test tube | K_2CrO_4 reacted w/ Pb^{2+} $\Rightarrow \text{PbCrO}_4$ (yellow) |
| Conc. NH_3 | grey ppt | $\text{Hg}_2\text{Cl}_2 + \text{NH}_3 \rightarrow \text{HgNH}_2\text{Cl}$ (grey) $\text{Ag}(\text{NH}_3)_2^+$ soluble |
| Conc. HNO_3 | white ppt blue but turns red | $\text{Ag}(\text{NH}_3)_2^+ + \text{Cl}^- \rightarrow \text{AgCl}$ (white). Ag^+ present |

Table 3. Analysis of Group I ions (Unknown # = 3)

| Reagent | Observation | Conclusion |
|--------------------------|--------------------|--|
| 6 M HCl | white ppt | Carbon for GP I present (Ag^+ , Pb^{2+} , Hg^+) |
| K_2CrO_4 | solution is yellow | presence of Pb^{2+} |
| conc. NH_3 | grey ppt | $\text{Hg}_2\text{Cl}_2 + \text{NH}_3 \rightarrow \text{HgNH}_2\text{Cl} + \text{Hg}$ (grey) |
| conc. HNO_3 | Blue turned red | no white color |

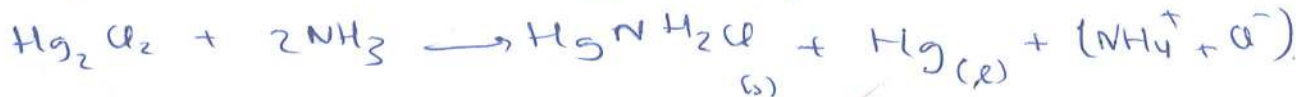
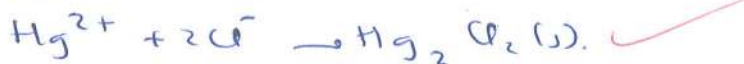
Results:

Cations present: Pb^{2+} , Hg_2^{2+} , Ag^+

Cations absent: Ag^+



Write the balanced net ionic equations for all the reactions involved in table 2.



(2)

(1)

(4)

(3)

Questions

1. The solubility of $Zn(OH)_2$ is 2.33×10^{-4} g/L, Calculate its solubility product constant.



$$K_{sp} = [Zn^{2+}][OH^-]^2 = s \cdot 2s^2 \Rightarrow K_{sp} = 5 \times 4s^2 = 4s^3$$

$$K_{sp} = 4s^3 = 4(2.33 \times 10^{-4})^3 = 5.06 \times 10^{-11}$$

11.5

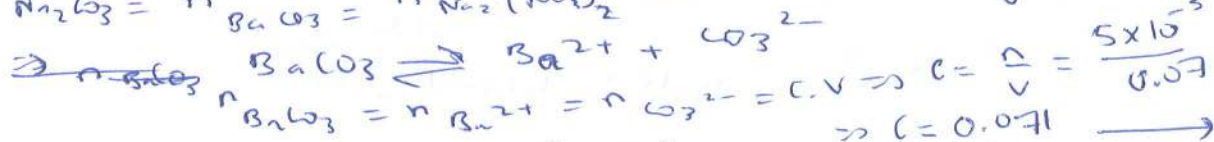
2. If 20.0 mL of 1.0 M $Ba(NO_3)_2$ are added to 50.0 mL of 0.10 M Na_2CO_3 , will $BaCO_3$ precipitate? K_{sp} of $BaCO_3 = 8.1 \times 10^{-9}$.



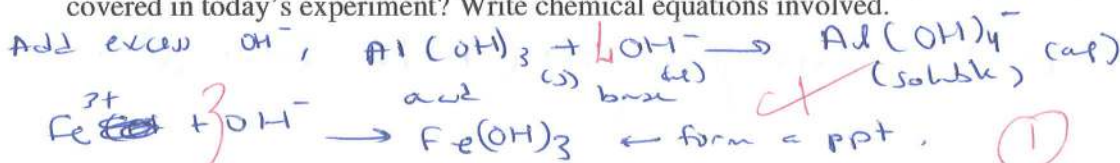
$$n_{Ba(NO_3)_2} = C \cdot V = 1.0 \times 20.0 \times 10^{-3} = 0.02 \rightarrow \text{excess}$$

$$n_{Na_2CO_3} = C \cdot V = 0.10 \times 50.0 \times 10^{-3} = 5 \times 10^{-3} \rightarrow \text{limiting}$$

$$n_{Na_2CO_3} = n_{BaCO_3} = n_{Na_2(NO_3)_2} \text{ according to stoichiometry}$$



3. How would you separate a mixture of Al^{3+} and Fe^{3+} using methods of separation covered in today's experiment? Write chemical equations involved.



4. In a group 1 analysis, a student adds HCl to the unknown solution to make $[Cl^-] = 0.15$ M. some $PbCl_2$ precipitates. Calculate the concentration of Pb^{2+} remaining in solution. K_{sp} of $PbCl_2$ is 2.4×10^{-4} .



$$K_{sp} = [Pb^{2+}][Cl^-]^2$$

$$[Pb^{2+}] = \frac{K_{sp}}{[Cl^-]^2}$$

$$= \frac{2.4 \times 10^{-4}}{(0.15)^2} = 1.1 \times 10^{-3} \text{ mol/L}$$

1

2)

$$Q = [Ba^{2+}][CO_3^{2-}]$$

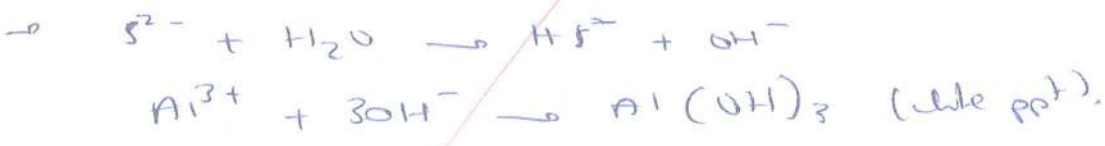
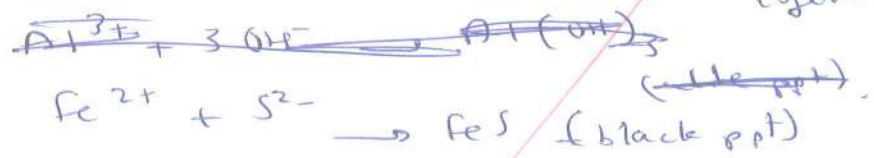
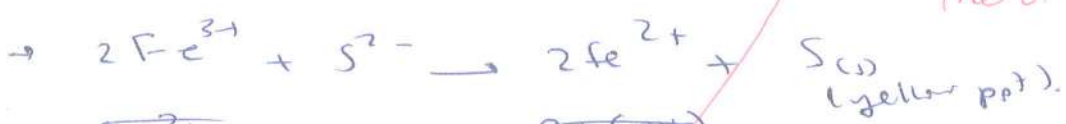
$$= (0.071)^2 = 5.041 \times 10^{-3}$$

$$K_{sp} = 8.1 \times 10^{-9}$$

$K_{sp} < Q \Rightarrow$ it'll precipitate
BaCO₃ will precipitate.

2

3) or based on ↓ solubility
 difference in



No
 need