26,5 + 0,5 = 27/30

Chemistry 205 Report

Qualitative Analysis

Name: [illegible]

Date: 27/4/2012

Section: _____

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

Part I: Qualitative Analysis

(1)

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 $[Ag(OH)]$	white ppt $(AgCl)$	light grey (Ag_2S)	~~black ppt~~ clear	$Ag(NH_3)^+$
Pb^{2+}	cloudy/turbid white $Pb(OH)_2$	$PbCl_2$ white ppt	dark grey (PbS)	white ppt	$Pb(OH)_2$
Hg_2^{2+}	white ppt ~~yellow~~ $Hg_2(OH)_2$	white ppt ~~tetar~~ $HgCl_2$	greenish (Hg_2S) yellow	grey ppt	$Hg_2(OH)_2$
Hg^{2+}	~~no reaction~~ yellow/ $Hg(OH)_2$	white ppt $HgCl_2$	brown & HgS	white ppt	$Hg(OH)_2$
Cu^{2+}	cloudy $Cu(OH)_3$ blue ppt	—	Dark CuS green	dark blue	$Cu(NH_3)_4^{2+}$ $Cu(OH)_2$
Al^{3+}	~~Al~~ $(OH)_3$ white ~~precipitate~~ ppt	—	~~colourless~~ $Al(OH)_3$ white ppt	white ppt	$Al(OH)_3$
Fe^{3+}	$Fe(OH)_3$ brown ppt	—	turbid FeS w/ 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	—	

(10)

Part II: Analysis of Group I cations

Table 2. Analysis of Group I ions (Known)

Reagent	Observation	Conclusion
6 M HCl	white ppt	Cation of grp I (Ag^+, Pb^{2+}, Hg_2^{2+})
K_2CrO_4	yellow ppt in Pb^{2+} test tube	K_2CrO_4 reacted w/ Pb^{2+} ⇒ $PbCrO_4$ (yellow)
Conc. NH_3	grey ppt	$Hg_2Cl_2 + NH_3 \rightarrow HgNH_2Cl$ (grey) $Ag(NH_3)_2$ soluble
Conc. HNO_3	white ppt blue but turns red	$Ag(NH_3)_2 + Cl^- \rightarrow AgCl$ (white). Ag^+ present

(2)

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

Reagent	Observation	Conclusion
6 M HCl	white ppt	cation of grp I present (Ag^+, Pb^{2+}, Hg_2^{2+})
K_2CrO_4	solution is yellow	presence of Pb^{2+}
conc. NH_3	grey ppt	$Hg_2Cl_2 + NH_3 \rightarrow HgNH_2Cl + Hg$ (grey)
conc. HNO_3	Blue turned red	no white color

(1)

Results:

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

Cations absent: ~~Ag^+~~

(4)

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

(3)

$Ag^+ + Cl^- \rightarrow AgCl_{(s)}$

$Pb^{2+} + 2Cl^- \rightarrow PbCl_{2(s)}$

$Hg_2^{2+} + 2Cl^- \rightarrow Hg_2Cl_{2(s)}$

$Pb^{2+} + CrO_4^{2-} \rightarrow PbCrO_4$

$AgCl + 2NH_3 \rightarrow Ag(NH_3)_2^+ + Cl^-$

$Ag(NH_3)_2^+ + Cl^- + 2HNO_3 \rightarrow AgCl + 2(NH_4^+ + NO_3^-)$

$Hg_2Cl_2 + 2NH_3 \rightarrow HgNH_2Cl_{(s)} + Hg_{(l)} + (NH_4^+ + Cl^-)$

Questions

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

$Zn(OH)_2 \rightarrow Zn^{2+} + 2OH^-$

$K_{sp} = [Zn^{2+}][OH^-]^2$

$= s \cdot 2s \Rightarrow K_{sp} = s \times 4s^2 = 4s^3$ (1.5)

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

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 $BaCO_3 = 8.1 \times 10^{-9}$.

$Ba(NO_3)_2$ { $V = 20.0$ ml, $C = 1.0$ M } Na_2CO_3 { $V = 50.0$ ml, $C = 0.10$ M }

$Ba(NO_3)_2 + Na_2CO_3 \rightarrow BaCO_3 + Na_2(NO_3)_2$

~~$Q = [BaCO_3][Na_2(NO_3)_2]$~~

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

$n(Na_2CO_3) = C.V = 0.10 \times 50.0 \times 10^{-3} = 5 \times 10^{-3}$ → limiting

$n_{Na_2CO_3} = n_{BaCO_3} = n_{Na_2(NO_3)_2}$ according to stochiometry

~~$\Rightarrow n_{BaCO_3}$~~ $BaCO_3 \rightleftharpoons Ba^{2+} + CO_3^{2-}$

$n_{BaCO_3} = n_{Ba^{2+}} = n_{CO_3^{2-}} = C.V \Rightarrow C = \frac{n}{V} = \frac{5 \times 10^{-3}}{0.07}$

$\Rightarrow C = 0.071$ →

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.

Based on amphoterism;

Add excess OH^-, $Al(OH)_3(s) + OH^-(aq) \rightarrow Al(OH)_4^-$ (soluble)

$Fe^{3+} + 3OH^- \rightarrow Fe(OH)_3$ ← form a ppt. (1)

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}.

$PbCl_2 \rightarrow Pb^{2+} + Cl^-$

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

$[Pb^{2+}] = \frac{K_{sp}}{[Cl^-]} = \frac{2.4 \times 10^{-4}}{0.15} = 1.6 \times 10^{-3}$ 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

$BaCO_3$ will precipitate.

(2)

3) or based on ↓ solubility difference in

No need

→ $2Fe^{3+} + S^{2-} \longrightarrow 2Fe^{2+} + S_{(s)}$ (yellow ppt).

~~$Al^{3+} + 3OH^- \longrightarrow Al(OH)_3$ (white ppt).~~

$Fe^{2+} + S^{2-} \longrightarrow FeS$ (black ppt)

→ $S^{2-} + H_2O \longrightarrow HS^- + OH^-$

$Al^{3+} + 3OH^- \longrightarrow Al(OH)_3$ (white ppt).