4.5

Precipitate Reactions and Selective Precipitation Assignment

Part A: Net Ionic Equations

Write the balanced and net-ionic equation for the following double replacement reactions. Note that all reactants are aqueous. All states must be shown. If a reaction does not occur you must indicate that and a balanced equation is not necessary.

1) Potassium phosphate and calcium nitrate.

$2K_3PO_{4(aq)} + 3Ca(NO_3)_{2(aq)} \rightarrow 6KNO_{3(aq)} + Ca_3(PO_4)_{2(s)}$

$3Ca^{2+}_{(aq)} + 2PO_4^{3-} \rightarrow Ca_3(PO_4)_{2(s)}$

2) Barium chloride and sodium sulfate.

$BaCl_{2(aq)} + Na_2SO_{4(aq)} \rightarrow BaSO_{4(s)} + 2NaCl_{(aq)}$

$Ba^{2+}_{(aq)} + SO_4^{2-}{}_{(aq)} \rightarrow BaSO_{4(s)}$

3) Sodium acetate and silver nitrate.

$NaCH_3COO_{(aq)} + AgNO_{3(aq)} \rightarrow NaNO_{3(aq)} + AgCH_3COO_{(s)}$

$Ag^{+}_{(aq)} + CH_3COO^{-}_{(aq)} \rightarrow AgCH_3COO_{(s)}$

4) Hydrochloric acid and copper (II) nitrate

$2HCl_{(aq)} + Cu(NO_3)_{2(aq)} \rightarrow 2HNO_{3(aq)} + CuCl_{2(aq)}$

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5) Calcium iodide and potassium carbonate.

$CaI_{2(aq)} + K_2CO_{3(aq)} \rightarrow CaCO_{3(s)} + 2KI_{(aq)}$

$Ca^{2+}_{(aq)} + CO_3^{2-}{}_{(aq)} \rightarrow CaCO_{3(s)}$

Part B Selective Precipitation

1. An aqueous solution containing the following cations: Ca^{2+} Ag^{+} Cu^{2+} K^{+}

In order to separate them, the following solutions are available: Na_2S Na_2CO_3 NaBr

If we wish to separate the cations by causing only one cation to precipitate out of solution at a time:

a) in what order should the solutions Na_2S, Na_2CO_3, and NaBr be added?

b) identify the three precipitates that form after the addition of those solutions.

c) which one cation will remain in solution?

	Ca^{2+}	Ag^{+}	Cu^{2+}	K^{+}
S^{2-}	Sol	PPT	PPT	Sol
CO_3^{2-}	PPT	PPT	PPT	Sol
Br^{-}	Sol	PPT	Sol	Sol

a) b)

① $NaBr \rightarrow AgBr_{(s)}$

② $Na_2S \rightarrow CuS_{(s)}$

③ $Na_2CO_3 \rightarrow CaCO_{3(s)}$

c) K^{+} is the only ion left in solution

2. We wish to separate the cations from a mixture containing the following solutions:

$Ra(NO_3)_2$, $Mg(NO_3)_2$, and $AgNO_3$

In order to do so we are given the following separate solutions: K_2SO_4, K_2S, and KOH

In what order should we add the separate solutions in order to remove the cations by selective precipitation? List the precipitates that form, in the proper order.

	Ra^{2+}	Mg^{2+}	Ag^{+}
SO_4^{2-}	PPT	Sol	PPT
S^{2-}	Sol	Sol	PPT
OH^{-}	Sol	PPT	PPT

a) b)

① $K_2S \rightarrow Ag_2S_{(s)}$

② $KOH \rightarrow Mg(OH)_{2(s)}$

(can be)

③ $K_2SO_4 \rightarrow RaSO_{4(s)}$

3. You want to separate the followings cations from a solution: Be^{2+}, Sr^{2+}, and Ag^{+}. If you are given NH_4Br, Na_2SO_3, and H_2SO_4, list the order the substances must be added and the precipitates that form in each step.

	Be^{2+}	Sr^{2+}	Ag^{+}
Br^{-}	Sol	Sol	PPT
SO_3^{2-}	PPT	PPT	PPT
SO_4^{2-}	Sol	PPT	PPT

a) b)

① $NH_4Br \rightarrow AgBr_{(s)}$

② $H_2SO_4 \rightarrow SrSO_{4(s)}$

③ $Na_2SO_3 \rightarrow BeSO_{3(s)}$

4. An aqueous solution contains a mixture of Ba^{2+}, Pb^{2+} and Ca^{2+}. List 3 substances that can be added in the correct order such that 1 cation will precipitate out at a time. List the precipitate that forms in each step.

	Ba^{2+}	Pb^{2+}	Ca^{2+}
Br^{-}	Sol	PPT	Sol
SO_4^{2-}	PPT	PPT	PPT
OH^{-}	Sol	PPT	PPT

order precip

① $NaBr \rightarrow PbBr_{2(s)}$

② $NaOH \rightarrow Ca(OH)_{2(s)}$

③ $Na_2SO_4 \rightarrow BaSO_{4(s)}$

answers will vary, but as an example.