Single and double replacement (Homework)

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1.
On the basis of the general solubility rules given in Table 7.1, predict the identity of the precipitate that forms when aqueous solutions of the following substances are mixed. Indicate which rules from the table apply to each case. (Type your answer using the format H2O for H_2O and (NH4)2CO3 for $(NH_4)_2CO_3$. If no precipitate forms, type NONE. Select all that apply.)

General Rules for Solubility of Ionic Compounds (Salts) in Water at 25 °C

1. Most nitrate (NO_3^-) salts are soluble.
2. Most salts of Na^+, K^+, and NH_4^+ are soluble.
3. Most chloride salts are soluble. Notable exceptions are AgCl, $PbCl_2$, and Hg_2Cl_2.
4. Most sulfate salts are soluble. Notable exceptions are $BaSO_4$, $PbSO_4$, and $CaSO_4$.
5. Most hydroxide compounds are only slightly soluble.* The important exceptions are NaOH and KOH. $Ba(OH)_2$ and $Ca(OH)_2$ are only moderately soluble.
6. Most sulfide (S^{2-}), carbonate (CO_3^{2-}), and phosphate (PO_4^{3-}) salts are only slightly soluble.*

*The terms *insoluble* and *slightly soluble* really mean the same thing: such a tiny amount dissolves that it is not possible to detect it with the naked eye.

Table 7.1

(a) mercury(I) nitrate, $Hg_2(NO_3)_2$, and potassium chloride, KCl

(b) potassium chloride, KCl, and iron(II) sulfate, $FeSO_4$

(c) lead(II) nitrate, $Pb(NO_3)_2$, and hydrochloric acid, HCl

(d) calcium nitrate, $Ca(NO_3)_2$, and sodium chloride, NaCl

(e) barium nitrate, $Ba(NO_3)_2$, and sodium sulfate, Na_2SO_4

(f) iron(III) chloride, $FeCl_3$, and phosphoric acid, H_3PO_4

2.
On the basis of the general solubility rules given in Table 7.1, write a balanced molecular equation for the precipitation reactions that take place when the following aqueous solutions are mixed. If no precipitation reaction is likely for the reactants given, explain why. (Type your answer using the format (NH4)2CO3 for $(NH_4)_2CO_3$. If there is no reaction, type NR in all answer boxes. Use the lowest possible coefficients.)

(a) ammonium chloride, NH_4Cl, and sulfuric acid, H_2SO_4

(b) potassium carbonate, K_2CO_3, and tin(IV) chloride, $SnCl_4$
$2\ K_2CO_3(aq) + 1\ SnCl_4(aq) \rightarrow 1\ Sn(CO3)2(s) + 4\ KCl(aq)$

(c) ammonium chloride, NH_4Cl, and lead(II) nitrate, $Pb(NO_3)_2$

(d) copper(II) sulfate, $CuSO_4$, and potassium hydroxide, KOH
$1\ CuSO_4(aq) + 2\ KOH(aq) \rightarrow 1\ Cu(OH)2(s) + 1\ K2SO4(aq)$

(e) sodium phosphate, Na_3PO_4, and chromium(III) chloride, $CrCl_3$

(f) ammonium sulfide, $(NH_4)_2S$, and iron(III) chloride, $FeCl_3$

3.
For each of the following precipitation reactions, complete and balance the equations. Indicate which product is the precipitate and which rules apply. (Type your answer using the format (NH4)2CO3 for $(NH_4)_2CO_3$. Use the lowest possible coefficients.)
(a) $Ba(NO_3)_2)(aq) + (NH_4)_2SO_4(aq) \rightarrow$?

(b) $CoCl_3(aq) + NaOH(aq) \rightarrow$?

(c) $FeCl_3(aq) + (NH_4)_2S(aq) \rightarrow$?

4.
What salt would form when each of the following strong acid/strong base reactions takes place? (Type your answer using the format H3PO4 for H_3PO_4, $(NH_4)_2CO_3$ for (NH4)2CO3, [NH4]+ for NH_4^+, and [Ni(CN)4]2- for $Ni(CN)_4^{2-}$.)
(a) $HCl(aq) + KOH(aq) \rightarrow$
(b) $RbOH(aq) + HNO_3(aq) \rightarrow$
(c) $HClO_4(aq) + NaOH(aq) \rightarrow$

5.
Identify each of the following unbalanced reaction equations as belonging to one or more of the following categories: precipitation, acid-base, or oxidation-reduction. (Select all that apply.)

(a) $Zn(s) + CuSO_4(aq) \rightarrow ZnSO_4(aq) + Cu(s)$

(b) $KOH(aq) + CuSO_4(aq) \rightarrow Cu(OH)_2(s) + K_2SO_4(aq)$

(c) $NO(g) + O_2(g) \rightarrow NO_2(g)$

(d) $HCl(aq) + KOH(aq) \rightarrow H_2O(l) + KCl(aq)$

(e) $Ca(OH)_2(aq) + H_2SO_4(aq) \rightarrow CaSO_4(s) + H_2O(l)$

(f) $K_2SO_4(aq) + Ba(NO_3)_2(aq) \rightarrow BaSO_4(s) + KNO_3(aq)$

(g) $BaCl_2(aq) + H_2SO_4(aq) \rightarrow BaSO_4(s) + HCl(aq)$

(h) $H_2SO_4(aq) + Cu(s) \rightarrow CuSO_4(aq) + H_2(g)$

(i) $Ca(OH)_2(s) + HNO_3(aq) \rightarrow Ca(NO_3)_2(aq) + H_2O(l)$