AP Chemistry: Worksheet--Molecular, Ionic and Net Ionic Equations

1. Strontium compounds are often used in flares because their flame color is bright red. One industrial process to produce low-solubility strontium compounds (that are less affected by getting wet) involves the reaction of aqueous solutions of strontium nitrate and sodium carbonate. Write the balanced molecular equation, the total ionic equation and the net ionic equation for this reaction.

2. Placing aluminum foil in any solution containing aqueous copper(II) ions will result in a reaction. The reaction is slow to begin with, then proceeds rapidly.
a) Referring to a solubility table, name at least four ionic compounds that could be dissolved in water to make a solution containing aqueous copper(II) ions.
b) Write a balanced chemical equation for the reaction of aluminum with one of the compounds you suggested in a).
c) Write the total ionic equation for the reactions.
d) Write the total net ionic equation for the reactions.

3. One industrial method of producing bromine is to react seawater, containing a low concentration of sodium bromide, with chlorine gas. The chlorine gas is bubbled through the seawater in a specially designed vessel. Write the net ionic equation for this reaction.

4. In a hard-water analyses, sodium oxalate solution reacts with calcium hydrogen carbonate (in the hard water) to precipitate a calcium compound. Write the net ionic equation for this reaction.

5. In a laboratory test of the metal activity series, a student places a strip of lead metal into aqueous silver nitrate. Write the net ionic equation for this reaction.

6. Some natural waters contain iron ions that affect the taste of the water and cause rust stains. Aeration converts any iron(II) ions into iron(III) ions. A basic solution (contains hydroxide ions) is added to produce a precipitate.
a) Write the net ionic equation for the reaction of aqueous iron(II) ions and aqueous hydroxide ions.
b) What separation method is most likely to be used during this water treatment process?

7. A common method for the disposal of soluble lead water is to precipitate the lead as the low-solubility lead(II) silicate. Write the net ionic equation for the reaction of aqueous lead(II) nitrate and aqueous sodium silicate.

8. In a water treatment plant, sodium phosphate is added to remove calcium ions from the water. Write the net ionic equation for the reaction of aqueous calcium chloride and aqueous sodium phosphate.

9. As part of a recycling process, silver metal is recovered from a silver nitrate solution by reacting it with copper metal. Write the net ionic equation for this reaction.

10. Predict which of the following combinations of aqueous chemicals produce a precipitate. Write a net ionic equation (including any states of matter) for the formation of any precipitate.

a) lead(II) nitrate and calcium chloride
b) ammonium sulfide and zinc bromide
c) potassium iodide and sodium nitrate
d) silver sulfate and ammonium acetate
e) barium nitrate and ammonium phosphate
f) sodium hydroxide and calcium nitrate

11. Equal volume of 1.0 M solutions of each of the following pairs of solutions are mixed. Predict which combinations will form a precipitate and write net ionic equation for the predicted reactions.

a) $CuSO_{4(aq)}$ and $NaOH_{(aq)}$
b) $H_2SO_{4(aq)}$ and $NaOH_{(aq)}$
c) $Na_3PO_{4(aq)}$ and $CaCl_{2(aq)}$
d) $AgNO_{3(aq)}$ and $KCl_{(aq)}$
e) $MgSO_{4(aq)}$ and $LiBr_{(aq)}$
f) $CuNO_{3(aq)}$ and $NaCl_{(aq)}$

12. A lab technician uses 1.0 M $Na_2CO_{3(aq)}$ to precipitate metal ions from waste solutions. The resulting filtered solids can be disposed of more easily than large volumes of solution. Write net ionic equations for the reaction between $Na_2CO_{3(aq)}$ and each of the following waste solutions.

a) $Zn(NO_3)_{2(aq)}$
b) $Pb(NO_3)_{2(aq)}$
c) $Fe(NO_3)_{3(aq)}$
d) $CuSO_{4(aq)}$
e) $AgNO_{3(aq)}$
f) $NiCl_{2(aq)}$
g) Defend the technicians choice of $Na_2CO_{3(aq)}$ as the excess reagent.

13. The purification of water can involve several precipitation reactions. Write balanced net ionic equation to represent the reactions described below.

a) aqueous aluminum sulfate reacts with aqueous calcium hydroxide
b) aqueous sodium phosphate reacts with dissolved calcium bicarbonate
c) dissolved magnesium bicarbonate reacts with aqueous calcium hydroxide
d) aqueous calcium hydroxide reacts with dissolved iron(III) sulfate

14. What two conditions must be fulfilled by a balanced ionic equation?

15. Write ionic and net ionic equations for these reactions.

a) $(NH_4)_2CO_{3(aq)} + MgCl_{2(aq)} \rightarrow 2\ NH_4Cl_{(aq)} + MgCO_{3(s)}$

b) $CuCl_{2(aq)} + 2\ NaOH_{(aq)} \rightarrow Cu(OH)_{2(s)} + 2\ NaCl_{(aq)}$
c) $3\ FeSO_{4(aq)} + 2\ Na_3PO_{4(aq)} \rightarrow Fe_3(PO_4)_{2(s)} + 3\ Na_2SO_{4(aq)}$
d) $2\ AgC_2H_3O_{2(aq)} + NiCl_{2(aq)} \rightarrow 2\ AgCl_{(s)} + Ni(C_2H_3O_2)_{2(aq)}$

16. Write ionic and net ionic equations for these reactions.
a) $CuSO_{4(aq)} + BaCl_{2(aq)} \rightarrow CuCl_{2(aq)} + BaSO_{4(s)}$
b) $Fe(NO_3)_{3(aq)} + LiOH_{(aq)} \rightarrow LiNO_{3(aq)} + Fe(OH)_{3(s)}$
c) $Na_3PO_{4(aq)} + CaCl_{2(aq)} \rightarrow Ca_3(PO_4)_{2(s)} + NaCl_{(aq)}$
d) $Na_2S_{(aq)} + AgC_2H_3O_{2(aq)} \rightarrow NaC_2H_3O_{2(aq)} + Ag_2S_{(s)}$

17. Aqueous solutions of sodium sulfide, Na_2S, and copper nitrate, $Cu(NO_3)_2$, are mixed. A precipitate of copper sulfide, CuS, forms at once. Left behind is a solution of sodium nitrate, $NaNO_3$. Write the net ionic equation for this reaction.

18. Silver bromide is the chief light-sensitive substance used in the manufacture of photographic film. It can be prepared by mixing solutions of $AgNO_3$ and NaBr. Write molecular, ionic and net ionic equations for this reaction.

19. Trisodium phosphate (TSP), Na_3PO_4, is a useful cleaning agent, but it must be handled with care because its solutions are quite caustic. If a solution of Na_3PO_4 is added to one containing a calcium salt such as $CaCl_2$, a precipitate of calcium phosphate is formed. Write molecular, ionic and net ionic equations for this reaction.

20. Milk of magnesia is a suspension of solid magnesium hydroxide, $Mg(OH)_2$, in water. This solid can be made by adding a solution of sodium hydroxide, NaOH, to a solution of magnesium chloride, $MgCl_2$, which causes $Mg(OH)_2$ to precipitate and leaves sodium chloride in solution. Write molecular, ionic and net ionic equations for this reaction.

21. Write molecular, ionic and net ionic equations for any reactions that occur between the following pairs of compounds. If no reaction occurs, write 'N.R.'
a) $CuCl_{2(aq)}$ and $(NH_4)_2CO_{3(aq)}$
b) $HCl_{(aq)}$ and $MgCO_{3(aq)}$
c) $ZnCl_{2(aq)}$ and $AgC_2H_3O_{2(aq)}$
d) $MnO_{(s)}$ and $H_2SO_{4(aq)}$
e) $FeS_{(s)}$ and $HCl_{(aq)}$