5. For each word description, write the balanced molecular equation, and identify the product of the reaction.

   a. Aqueous solutions of sodium sulfate and lead(II) nitrate are mixed. One of the products is a white solid.
   b. Aqueous solutions of potassium hydroxide and nickel(II) chloride are mixed. One of the products is a green solid.
   c. Aqueous solutions of potassium sulfide and zinc nitrate are mixed. A pale yellow solid is produced.
   d. Aqueous solutions of silver nitrate and ammonium phosphate are mixed. A white solid is produced.

6. For each of the balanced equations below, write the complete ionic equation.

   a. $3\ CaCl_2(aq) + 2\ Na_3PO_4(aq) \rightarrow Ca_3(PO_4)_2(s) + 6\ NaCl(aq)$
   b. $Cu(NO_3)_2(aq) + K_2S(aq) \rightarrow CuS(s) + 2\ KNO_3(aq)$
   c. $2\ AgNO_3(aq) + K_2SO_4(aq) \rightarrow Ag_2SO_4(s) + 2\ KNO_3(aq)$

7. Complete and balance the equations below and identify the spectator ions.

   a. $Ca(NO_3)_2(aq) + K_2SO_4(aq) \rightarrow$
   b. $(NH_4)_2CO_3(aq) + CuCl_2(aq) \rightarrow$
   c. $NaOH(aq) + Pb(NO_3)_2(aq) \rightarrow$
   d. $Na_2S(aq) + Zn(NO_3)_2(aq) \rightarrow$
   e. $CoCl_2(aq) + Ca(OH)_2(aq) \rightarrow$

8. Write the net ionic equation for each reaction.

   a. $K_2CO_3(aq) + CaCl_2(aq) \rightarrow CaCO_3(s) + 2\ KCl(aq)$
   b. $Pb(NO_3)_2(aq) + (NH_4)_2S(aq) \rightarrow 2\ NH_4NO_3(aq) + PbS(s)$
   c. $2\ LiCl(aq) + 2\ Hg_2(NO_3)_2(aq) \rightarrow Hg_2Cl_2(s) + 2\ LiNO_3(aq)$
   d. $2\ NaOH(aq) + MgCl_2(aq) \rightarrow Mg(OH)_2(s) + 2\ NaCl(aq)$

9. What salts in aqueous solutions could you mix together to produce the solids below?

   a. $Zn(OH)_2$
   b. $Ba_3(PO_4)_2$
   c. $PbCl_2$
   d. $CaSO_4$
   e. $CoCO_3$
   f. Ag_2SO_4

10. Which of the substances below are strong acids, which are strong bases, and which are neither of these?

   a. HNO_3
   b. $C_2H_4O_2$
   c. H_2SO_4
   d. HCl
   e. NaCl
   f. K_2SO_4

11. Write complete ionic equations for the reactions below.

   a. Sodium hydroxide reacts with sulfuric acid.
   b. Hydrochloric acid reacts with potassium hydroxide.
   c. Nitric acid reacts with sodium hydroxide.

12. Write net ionic equations for each reaction in Problem 11.

13. Which of the reactions below are acid/base reactions?

13. Which of the reactions below are acid/base reactions?

a. $K_2SO_4(aq) + Pb(NO_3)(aq) \rightarrow PbSO_4(s) + 2\ KNO_3(aq)$
b. $KOH(aq) + HNO_3(aq) \rightarrow KNO_3(aq) + H_2O(l)$
c. $H_2SO_4(aq) + 2\ NaOH(aq) \rightarrow Na_2SO_4(aq) + 2\ H_2O(l)$
d. $Na_2CO_3(aq) + CoCl_2(aq) \rightarrow CoCO_3(s) + 2\ NaCl(aq)$

14. How many electrons do the elements below either gain or lose? For example, potassium atoms lose one electron.

$$K \rightarrow K^+ + e^-$$

a. Br_2
b. Mg
c. H_2
d. Al
e. O_2
f. S

16. For each reaction below, write equations showing the gain and loss of electrons.

a. $Cu(s) + 2AgNO_3(aq) \rightarrow 2Ag(s) + Cu(NO_3)_2(aq)$
b. $2HCl(aq) + Zn(s) \rightarrow H_2(g) + ZnCl_2(aq)$
c. $2NaBr(aq) + Cl_2(g) \rightarrow 2NaCl(aq) + Br_2(g)$
d. $2Hg(l) + O_2(g) \rightarrow 2HgO(s)$

17. Classify the reactions below as a precipitation reaction, an acid-base reaction, or an oxidation-reduction reaction.

a. $2NaCl(s) + Br_2(l) \rightarrow 2NaBr(s) + Cl_2(g)$
b. $Na_2SO_4(aq) + Pb(NO_3)_2(aq) \rightarrow PbSO_4(s) + 2NaNO_3(aq)$
c. $2NaOH(aq) + H_2SO_4(aq) \rightarrow 2H_2O(l) + Na_2SO_4(aq)$
d. $2AgNO_3(aq) + Fe(s) \rightarrow Fe(NO_3)_2(aq) + 2Ag(s)$
e. $2KOH(aq) + ZnCl_2(aq) \rightarrow Zn(OH)_2(s) + 2KCl(aq)$

18. Classify the reactions below as combustion, synthesis, or decomposition reactions.

a. $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$
b. $C_7H_{16}(g) + 11O_2(g) \rightarrow 7CO_2(g) + 8H_2O(g)$
c. $16Cu(s) + S_8(s) \rightarrow 8Cu_2S(s)$
d. $2NaNO_3(s) \rightarrow 2NaNO_2(s) + O_2(g)$
e. $SO_3(g) + H_2O(l) \rightarrow H_2SO_4(l)$

19. Write balanced equations for each of the word descriptions. Classify each reaction as precipitation, oxidation-reduction, or acid-base.

a. Ethyl alcohol, a gasoline additive, burns in the presence of oxygen gas to produce carbon dioxide and water vapor.
b. Aqueous solutions of ammonium sulfide and lead nitrate are mixed to produce solid lead sulfide and aqueous ammonium nitrate.
c. Aluminum metal reacts with oxygen to produce solid aluminum oxide.
d. Sodium metal reacts with liquid water to produce aqueous sodium hydroxide and hydrogen gas.
e. Aqueous solutions of potassium hydroxide and nitric acid are mixed to produce aqueous potassium nitrate and liquid water.
f. Aqueous solutions of sodium phosphate and aqueous sodium nitrate.