CHAPTER 6

Chemical Reactions: An Introduction

CHAPTER ANSWERS

1. The types of evidence for a chemical reaction mentioned in the text are a change in color, formation of a solid, evolution of a gas, and absorption or evolution of heat. Other bits of evidence that might also be observed include appearance or disappearance of a characteristic odor or separation of the reaction mixture into layers of visibly different composition.
2. Most of these products contain a peroxide, which decomposes releasing oxygen gas.
3. The fact that the material in the drain that did *not* dissolve in water dissolves when the drain cleaner is added suggests that rather than simple dissolving, the material in the drain has undergone a chemical change that makes it soluble. You may also have noticed that the drain cleaner evolved *heat* when added to the drain; evolution or absorption of heat is also often a sign of a chemical reaction.
4. Bubbling takes place as the hydrogen peroxide chemically decomposes into water and oxygen gas.
5. The container of a flashlight battery usually consists of zinc, which is one of the substances involved in the chemical reaction in the battery that generates the electricity. The fact that the zinc decays until the battery leaks is a sign that a chemical reaction has taken place.
6. The two components are both liquids, but harden to a solid when combined. There is also heat evolved during the reaction.
7. A and B are the reactants; C and D are the products; the arrow indicates that a reaction takes place.
8. atoms
9. the same as
10. the same
11. The physical state is included because it helps us visualize the reaction taking place (for example, if a solid forms when two liquids are mixed together, that is very significant). The physical state is also included because it may influence some measured properties of the reaction. For example, if water vapor is formed in a reaction, a different quantity of energy may be involved than if liquid water were formed (See Chapter 10.). We indicate the physical states as follows: (*s*), solid; (*l*), liquid; (*g*), gas; (*aq*) aqueous solution.
12. water
13. $Zn(s) + HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$
14. $H_2O_2(aq) \rightarrow H_2(g) + O_2(g)$
15. $H_2(g) + O_2(g) \rightarrow H_2O(g)$

16. $AgNO_3(aq) + HCl(aq) \rightarrow AgCl(s) + HNO_3(aq)$

    $Pb(NO_3)_2(aq) + HCl(aq) \rightarrow PbCl_2(s) + HNO_3(aq)$

17. $Ag(s) + HNO_3(aq) \rightarrow AgNO_3(aq) + NO(g) + H_2(g)$

18. $C_3H_8(g) + O_2(g) \rightarrow CO_2(g) + H_2O(g)$

    $C_3H_3(g) + O_2(g) \rightarrow CO(g) + H_2O(g)$

19. $B_2O_3(s) + Mg(s) \rightarrow B(g) + MgO(s)$

20. $CaCO_3(s) + HCl(aq) \rightarrow CaCl_2(aq) + H_2O(l) + CO_2(g)$

21. $P_4(s) + Cl_2(g) \rightarrow PCl_3(s)$

22. $SiO_2(s) + C(s) \rightarrow Si(s) + CO(g)$

23. $NH_4NO_3(s) \rightarrow N_2O(g) + H_2O(g)$

24. $H_2S(g) + O_2(g) \rightarrow SO_2(g) + H_2O(g)$

25. $C_2H_2(g) + O_2(g) \rightarrow CO_2(g) + H_2O(g)$

26. $SO_2(g) + H_2O(l) \rightarrow H_2SO_3(aq)$

    $SO_3(g) + H_2O(l) \rightarrow H_2SO_4(aq)$

27. $BaO(s) + Al(s) \rightarrow Ba(s) + Al_2O_3(s)$

    $CaO(s) + Al(s) \rightarrow Ca(s) + Al_2O_3(s)$

    $SrO(s) + Al(s) \rightarrow Sr(s) + Al_2O_3(s)$

28. $NO(g) + O_3(g) \rightarrow NO_2(g) + O_2(g)$

29. $CH_4(g) + Cl_2(g) \rightarrow CCl_4(l) + HCl(g)$

30. $NH_3(g) + HNO_3(aq) \rightarrow NH_4NO_3(s)$

31. $CaO(s) + H_2O(g) \rightarrow Ca(OH)_2(s)$

32. $Xe(g) + F_2(g) \rightarrow XeF_4(s)$

33. $NH_4NO_3(s) \rightarrow N_2(g) + O_2(g) + H_2O(g)$

34. $NH_4Cl(s) + NaOH(s) \xrightarrow{heat} NH_3(g) + H_2O(g) + NaCl(s)$

35. The subscripts in a formula really define what compound is present since the subscripts represent in what proportions the elements combine to form the compound. Changing the subscripts would be changing the identity of the compound.

36. whole numbers

37.

    a. $FeCl_3 + KOH \rightarrow Fe(OH)_3 + KCl$

    Balance chlorine: $FeCl_3 + KOH \rightarrow Fe(OH)_3 + 3KCl$

    Balance potassium: $FeCl_3 + 3KOH \rightarrow Fe(OH)_3 + 3KCl$

    Balanced equation: $FeCl_3(aq) + 3KOH(aq) \rightarrow Fe(OH)_3(s) + 3KCl(aq)$

b. $Pb(C_2H_3O_2)_2 + KI \rightarrow PbI_2 + KC_2H_3O_2$

Balance iodine: $Pb(C_2H_3O_2)_2 + 2KI \rightarrow PbI_2 + KC_2H_3O_2$

Balance potassium: $Pb(C_2H_3O_2)_2 + 2KI \rightarrow PbI_2 + 2KC_2H_3O_2$

Balanced equation: $Pb(C_2H_3O_2)_2(aq) + 2KI(aq) \rightarrow PbI_2(s) + KC_2H_3O_2(aq)$

c. $P_4O_{10} + H_2O \rightarrow H_3PO_4$

Balance phosphorus: $P_4O_{10} + H_2O \rightarrow 4H_3PO_4$

Balance hydrogen: $P_4O_{10} + 6H_2O \rightarrow 4H_3PO_4$

Balanced equation: $P_4O_{10}(s) + 6H_2O(l) \rightarrow 4H_3PO_4(aq)$

d. $Li_2O + H_2O \rightarrow LiOH$

Balance lithium: $Li_2O + H_2O \rightarrow 2LiOH$

Balanced equation: $Li_2O(s) + H_2O(l) \rightarrow 2LiOH(aq)$

e. $MnO_2 + C \rightarrow Mn + CO_2$ This equation is already balanced!

f. $Sb + Cl_2 \rightarrow SbCl_3$

This equation is more difficult to balance than it may appear. The problem arises in the fact that there are two Cl atoms on the left side of the equation, whereas there are three Cl atoms on the right side of the equation. To balance the chlorine atoms, we need to know the smallest whole number into which both two and three divide. This number is six: we need to adjust the coefficients of Cl_2 and $SbCl_3$ so that there will be six chlorine atoms on each side of the equation.

Balance chlorine: $Sb + 3Cl_2 \rightarrow 2SbCl_3$

Balance antimony: $2Sb + 3Cl_2 \rightarrow 2SbCl_3$

Balanced equation: $2Sb(s) + 3Cl_2(g) \rightarrow 2SbCl_3(s)$

g. $CH_4 + H_2O \rightarrow CO + H_2$

Balance hydrogen: $CH_4 + H_2O \rightarrow CO + 3H_2$

Balanced equation: $CH_4(g) + H_2O(g) \rightarrow CO(g) + 3H_2(g)$

h. $FeS + HCl \rightarrow FeCl_2 + H_2S$

Balance chlorine: $FeS + 2HCl \rightarrow FeCl_2 + H_2S$

Balanced equation: $FeS(s) + 2HCl(aq) \rightarrow FeCl_2(aq) + H_2S(g)$

38.

a. $Al(s) + CuO(s) \rightarrow Al_2O_3(s) + Cu(l)$

balance Al: $2Al(s) + CuO(s) \rightarrow Al_2O_3(s) + Cu(l)$

balance O: $2Al(s) + 3CuO(s) \rightarrow Al_2O_3(s) + Cu(l)$

balance Cu: $2Al(s) + 3CuO(s) \rightarrow Al_2O_3(s) + 3Cu(l)$

balanced equation: $2Al(s) + 3CuO(s) \rightarrow Al_2O_3(s) + 3Cu(l)$

b. $S_8(s) + F_2(g) \rightarrow SF_6(g)$

balance sulfur: $S_8(s) + F_2(g) \rightarrow \mathbf{8}SF_6(g)$

balance fluorine: $S_8(s) + \mathbf{24}F_2(g) \rightarrow 8SF_6(g)$

balanced equation: $S_8(s) + 24F_2(g) \rightarrow 8SF_6(g)$

c. $Xe(g) + F_2(g) \rightarrow XeF_6(s)$

balance fluorine: $Xe(g) + \mathbf{3}F_2(g) \rightarrow XeF_6(s)$

balanced equation: $Xe(g) + 3F_2(g) \rightarrow XeF_6(s)$

d. $NH_4Cl(g) + KOH(s) \rightarrow NH_3(g) + H_2O(g) + KCl(s)$

The equation is already balanced.

e. $SiC(s) + Cl_2(g) \rightarrow SiCl_4(l) + C(s)$

balance chlorine: $SiC(s) + \mathbf{2}Cl_2(g) \rightarrow SiCl_4(l) + C(s)$

balanced equation: $SiC(s) + 2Cl_2(g) \rightarrow SiCl_4(l) + C(s)$

f. $K_2O(s) + H_2O(l) \rightarrow KOH(aq)$

balance potassium: $K_2O(s) + H_2O(l) \rightarrow \mathbf{2}KOH(aq)$

balanced equation: $K_2O(s) + H_2O(l) \rightarrow 2KOH(aq)$

g. $N_2O_5(g) + H_2O(l) \rightarrow HNO_3(aq)$

balance nitrogen: $N_2O_5(g) + H_2O(l) \rightarrow \mathbf{2}HNO_3(aq)$

balanced equation: $N_2O_5(g) + H_2O(l) \rightarrow 2HNO_3(aq)$

h. $H_2S(g) + Cl_2(g) \rightarrow S_8(s) + HCl(g)$

balance sulfur: $\mathbf{8}H_2S(g) + Cl_2(g) \rightarrow S_8(s) + HCl(g)$

balance hydrogen: $8H_2S(g) + 8Cl_2(g) \rightarrow S_8(s) + \mathbf{16}HCl(g)$

balanced equation: $8H_2S(g) + 8Cl_2(g) \rightarrow S_8(s) + 16HCl(g)$

39.

a. $Br_2 + KI \rightarrow I_2 + KBr$

Balance bromine: $Br_2 + KI \rightarrow I_2 + \mathbf{2}KBr$

Balance iodine: $Br_2 + \mathbf{2}KI \rightarrow I_2 + 2KBr$

Balanced equation: $Br_2(g) + 2KI(aq) \rightarrow I_2(s) + 2KBr(aq)$

b. $K_2O_2 + H_2O \rightarrow KOH + O_2$

Balance hydrogen: $K_2O_2 + H_2O \rightarrow \mathbf{2}KOH + O_2$

Balance oxygen: $K_2O_2 + H_2O \rightarrow 2KOH + \mathbf{\frac{1}{2}}O_2$

Convert to whole numbers: $\mathbf{2}K_2O_2 + \mathbf{2}H_2O \rightarrow 4KOH + O_2$

Balanced equation: $2K_2O_2(s) + 2H_2O(l) \rightarrow 4KOH(aq) + O_2(g)$

c. $LiOH + CO_2 \rightarrow Li_2CO_3 + H_2O$

Balance lithium: $2LiOH + CO_2 \rightarrow Li_2CO_3 + H_2O$

Balanced equation: $2LiOH(s) + CO_2(g) \rightarrow Li_2CO_3(s) + H_2O(s)$

d. $K_2CO_3 + HNO_3 \rightarrow KNO_3 + H_2O + CO_2$

Balance potassium: $K_2CO_3 + HNO_3 \rightarrow 2KNO_3 + H_2O + CO_2$

Balance nitrate ion: $K_2CO_3 + 2HNO_3 \rightarrow 2KNO_3 + H_2O + CO_2$

Balanced equat.: $K_2CO_3(s) + 2HNO_3(aq) \rightarrow 2KNO_3(aq) + H_2O(l) + CO_2(g)$

e. $LiAlH_4 + AlCl_3 \rightarrow AlH_3 + LiCl$

We have an interesting situation here. There are four hydrogen atoms on the left side of the equation, but only three hydrogen atoms on the right side. The smallest number that is divisible by both four and three is 12. So the simplest way to begin balancing this equation is to take care of the hydrogen atoms so that there are 12 on each side.

Balance hydrogen: $3LiAlH_4 + AlCl_3 \rightarrow 4AlH_3 + LiCl$

Balance lithium: $3LiAlH_4 + AlCl_3 \rightarrow 4AlH_3 + 3LiCl$

Balanced equation: $3LiAlH_4(s) + AlCl_3(s) \rightarrow 4AlH_3(s) + 3LiCl(s)$

f. This equation is already balanced.

g. $Na_2SO_4 + C \rightarrow Na_2S + CO_2$

Balance oxygen: $Na_2SO_4 + C \rightarrow Na_2S + 2CO_2$

Balance carbon: $Na_2SO_4 + 2C \rightarrow Na_2S + 2CO_2$

Balanced equation: $Na_2SO_4(s) + 2C(s) \rightarrow Na_2S(s) + 2CO_2(g)$

h. $NaCl + H_2SO_4 \rightarrow Na_2SO_4 + HCl$

Balance sodium: $2NaCl + H_2SO_4 \rightarrow Na_2SO_4 + HCl$

Balance chlorine: $2NaCl + H_2SO_4 \rightarrow Na_2SO_4 + 2HCl$

Balanced equation: $2NaCl(s) + H_2SO_4(l) \rightarrow Na_2SO_4(s) + 2HCl(g)$

40.

a. $Na_2SO_4(aq) + CaCl_2(aq) \rightarrow CaSO_4(s) + 2NaCl(aq)$

b. $3Fe(s) + 4H_2O(g) \rightarrow Fe_3O_4(s) + 4H_2(g)$

c. $Ca(OH)_2(aq) + 2HCl(aq) \rightarrow CaCl_2(aq) + 2H_2O(l)$

d. $Br_2(g) + 2H_2O(l) + SO_2(g) \rightarrow 2HBr(aq) + H_2SO_4(aq)$

e. $3NaOH(s) + H_3PO_4(aq) \rightarrow Na_3PO_4(aq) + 3H_2O(l)$

f. $2NaNO_3(s) \rightarrow 2NaNO_2(s) + O_2(g)$

g. $2Na_2O_2(s) + 2H_2O(l) \rightarrow 4NaOH(aq) + O_2(g)$

h. $4Si(s) + S_8(s) \rightarrow 2Si_2S_4(s)$

41.

a. $2Li(s) + Cl_2(g) \rightarrow 2LiCl(s)$

b. $3Ba(s) + N_2(g) \rightarrow Ba_3N_2(s)$

c. $2NaHCO_3(s) \rightarrow Na_2CO_3(s) + CO_2(g) + H_2O(g)$

d. $2Al(s) + 6HCl(aq) \rightarrow 2AlCl_3(aq) + 3H_2(g)$

e. $2NiS(s) + 3O_2(g) \rightarrow 2NiO(s) + 2SO_2(g)$

f. $CaH_2(s) + 2H_2O(l) \rightarrow Ca(OH)_2(s) + 2H_2(g)$

g. $2H_2(g) + CO(g) \rightarrow CH_3OH(l)$

h. $2B_2O_3(s) + 6C(s) \rightarrow B_4C_3(s) + 3CO_2(g)$

42.

a. $4NaCl(s) + 2SO_2(g) + 2H_2O(g) + O_2(g) \rightarrow 2Na_2SO_4(s) + 4HCl(g)$

b. $3Br_2(l) + I_2(s) \rightarrow 2IBr_3(s)$

c. $Ca(s) + 2H_2O(g) \rightarrow Ca(OH)_2(aq) + H_2(g)$

d. $2BF_3(g) + 3H_2O(g) \rightarrow B_2O_3(s) + 6HF(g)$

e. $SO_2(g) + 2Cl_2(g) \rightarrow SOCl_2(l) + Cl_2O(g)$

f. $Li_2O(s) + H_2O(l) \rightarrow 2LiOH(aq)$

g. $Mg(s) + CuO(s) \rightarrow MgO(s) + Cu(l)$

h. $Fe_3O_4(s) + 4H_2(g) \rightarrow 3Fe(l) + 4H_2O(g)$

43.

a. $4KO_2(s) + 6H_2O(l) \rightarrow 4KOH(aq) + O_2(g) + 4H_2O_2(aq)$

b. $Fe_2O_3(s) + 6HNO_3(aq) \rightarrow 2Fe(NO_3)_3(aq) + 3H_2O(l)$

c. $4NH_3(g) + 5O_2(g) \rightarrow 4NO(g) + 6H_2O(g)$

d. $PCl_5(l) + 4H_2O(l) \rightarrow H_3PO_4(aq) + 5HCl(g)$

e. $C_2H_5OH(l) + 3O_2(g) \rightarrow 2CO_2(g) + 3H_2O(l)$

f. $2CaO(s) + 5C(s) \rightarrow 2CaC_2(s) + CO_2(g)$

g. $2MoS_2(s) + 7O_2(g) \rightarrow 2MoO_3(s) + 4SO_2(g)$

h. $FeCO_3(s) + H_2CO_3(aq) \rightarrow Fe(HCO_3)_2(aq)$

44.

a. $Ba(NO_3)_2(aq) + Na_2CrO_4(aq) \rightarrow BaCrO_4(s) + 2NaNO_3(aq)$

b. $PbCl_2(aq) + K_2SO_4(aq) \rightarrow PbSO_4(s) + 2KCl(aq)$

c. $C_2H_5OH(l) + 3O_2(g) \rightarrow 2CO_2(g) + 3H_2O(l)$

d. $CaC_2(s) + 2H_2O(l) \rightarrow Ca(OH)_2(s) + C_2H_2(g)$

e. $Sr(s) + 2HNO_3(aq) \rightarrow Sr(NO_3)_2(aq) + H_2(g)$

f. $BaO_2(s) + H_2SO_4(aq) \rightarrow BaSO_4(s) + H_2O_2(aq)$

g. $2AsI_3(s) \rightarrow 2As(s) + 3I_2(s)$

h. $2CuSO_4(aq) + 4KI(s) \rightarrow 2CuI(s) + I_2(s) + 2K_2SO_4(aq)$

45. $C_2H_2(g) + O_2(g) \rightarrow CO_2(g) + H_2O(g)$

46. $Na(s) + O_2(g) \rightarrow Na_2O_2(s)$

$Na_2O_2(s) + H_2O(l) \rightarrow NaOH(aq) + O_2(g)$

47. $KNO_3(s) + C(s) \rightarrow K_2CO_3(s) + CO(g) + N_2(g)$

48. $C_{12}H_{22}O_{11}(aq) + H_2O(l) \rightarrow 4C_2H_5OH(aq) + 4CO_2(g)$

49. $2H_2(g) + CO(g) \rightarrow CH_3OH(l)$

50. $2Al_2O_3(s) + 3C(s) \rightarrow 4Al(s) + 3CO_2(g)$

51. $Fe_3O_4(s) + 4H_2(g) \rightarrow 3Fe(s) + 4H_2O(g)$

$Fe_3O_4(s) + 4CO(g) \rightarrow 3Fe(s) + 4CO_2(g)$

52. $2Li(s) + S(s) \rightarrow Li_2S(s)$

$2Na(s) + S(s) \rightarrow Na_2S(s)$

$2K(s) + S(s) \rightarrow K_2S(s)$

$2Rb(s) + S(s) \rightarrow Rb_2S(s)$

$2Cs(s) + S(s) \rightarrow Cs_2S(s)$

$2Fr(s) + S(s) \rightarrow Fr_2S(s)$

53. $Fe(s) + O_2(g) \rightarrow FeO(s)$

$Fe(s) + O_2(g) \rightarrow Fe_2O_3(s)$

54. $BaO_2(s) + H_2O(l) \rightarrow BaO(s) + H_2O_2(aq)$

55. $4B(s) + 3O_2(g) \rightarrow 2B_2O_3(s)$

$B_2O_3(s) + 3H_2O(l) \rightarrow 2B(OH)_3(s)$

56. $2KClO_3(s) \rightarrow 2KCl(s) + 3O_2(g)$

57. $2H_2O_2(aq) \rightarrow 2H_2O(g) + O_2(g)$

58. $NH_3(g) + HCl(g) \rightarrow NH_4Cl(s)$

59. $CaSiO_3(s) + 6HF(g) \rightarrow CaF_2(aq) + SiF_4(g) + 3H_2O(l)$

60. The senses we call "odor" and "taste" are really chemical reactions of the receptors in our body with molecules in the food we are eating. The fact that the receptors no longer detect the "fishy" odor or taste suggests that adding the lemon juice or vinegar has changed the nature of the amines in the fish.

61. Many over-the-counter antacids contain either carbonate ion (CO_3^{2-}) or hydrogen carbonate ion (HCO_3^-). When either of these encounter stomach acid (primarily HCl), carbon dioxide gas is released.

62. $Fe(s) + S(s) \rightarrow FeS(s)$

63. $Na(s) + Cl_2(g) \rightarrow NaCl(s)$

64. $K_2CrO_4(aq) + BaCl_2(aq) \rightarrow BaCrO_4(s) + 2KCl(aq)$

65. $H_2S(g) + Pb(NO_3)_2(aq) \rightarrow PbS(s) + HNO_3(aq)$

66. $2NaCl(aq) + 2H_2O(l) \rightarrow 2NaOH(aq) + H_2(g) + Cl_2(g)$

$2NaBr(aq) + 2H_2O(l) \rightarrow 2NaOH(aq) + H_2(g) + Br_2(g)$

$2NaI(aq) + 2H_2O(l) \rightarrow 2NaOH(aq) + H_2(g) + I_2(g)$

67. $Mg(s) + O_2(g) \rightarrow MgO(s)$

68. $CaC_2(s) + 2H_2O(l) \rightarrow Ca(OH)_2(s) + C_2H_2(g)$

69. $P_4(s) + O_2(g) \rightarrow P_4O_{10}(g)$

70. $CuO(s) + H_2SO_4(aq) \rightarrow CuSO_4(aq) + H_2O(l)$

71. $PbS(s) + O_2(g) \rightarrow PbO(s) + SO_2(g)$

72. $Na_2SO_3(aq) + S(s) \rightarrow Na_2S_2O_3(aq)$

73.

a. $Cl_2(g) + 2KBr(aq) \rightarrow Br_2(l) + 2KCl(aq)$

b. $4Cr(s) + 3O_2(g) \rightarrow 2Cr_2O_3(s)$

c. $P_4(s) + 6H_2(g) \rightarrow 4PH_3(g)$

d. $2Al(s) + 3H_2SO_4(aq) \rightarrow Al_2(SO_4)_3(aq) + 3H_2(g)$

e. $PCl_3(l) + 3H_2O(l) \rightarrow H_3PO_3(aq) + 3HCl(aq)$

f. $2SO_2(g) + O_2(g) \rightarrow 2SO_3(g)$

g. $C_7H_{16}(l) + 11O_2(g) \rightarrow 7CO_2(g) + 8H_2O(g)$

h. $2C_2H_6(g) + 7O_2(g) \rightarrow 4CO_2(g) + 6H_2O(g)$

74.

a. $Cl_2(g) + 2KI(aq) \rightarrow 2KCl(aq) + I_2(s)$

b. $CaC_2(s) + 2H_2O(l) \rightarrow Ca(OH)_2(s) + C_2H_2(g)$

c. $2NaCl(s) + H_2SO_4(l) \rightarrow Na_2SO_4(s) + 2HCl(g)$

d. $CaF_2(s) + H_2SO_4(l) \rightarrow CaSO_4(s) + 2HF(g)$

e. $K_2CO_3(s) \rightarrow K_2O(s) + CO_2(g)$

f. $3BaO(s) + 2Al(s) \rightarrow Al_2O_3(s) + 3Ba(s)$

g. $2Al(s) + 3F_2(g) \rightarrow 2AlF_3(s)$

h. $CS_2(g) + 3Cl_2(g) \rightarrow CCl_4(l) + S_2Cl_2(g)$

75.

a. $SiCl_4(l) + 2Mg(s) \rightarrow Si(s) + 2MgCl_2(s)$

b. $2NO(g) + Cl_2(g) \rightarrow 2NOCl(g)$

c. $3MnO_2(s) + 4Al(s) \rightarrow 3Mn(s) + 2Al_2O_3(s)$

d. $16Cr(s) + 3S_8(s) \rightarrow 8Cr_2S_3(s)$

e. $4NH_3(g) + 3F_2(g) \rightarrow 3NH_4F(s) + NF_3(g)$

f. $Ag_2S(s) + H_2(g) \rightarrow 2Ag(s) + H_2S(g)$

g. $3O_2(g) \rightarrow 2O_3(g)$

h. $8Na_2SO_3(aq) + S_8(s) \rightarrow 8Na_2S_2O_3(aq)$

76.

a. $Pb(NO_3)_2(aq) + K_2CrO_4(aq) \rightarrow PbCrO_4(s) + 2KNO_3(aq)$

b. $BaCl_2(aq) + Na_2SO_4(aq) \rightarrow BaSO_4(s) + 2NaCl(aq)$

c. $2CH_3OH(l) + 3O_2(g) \rightarrow 2CO_2(g) + 4H_2O(g)$

d. $Na_2CO_3(aq) + S(s) + SO_2(g) \rightarrow CO_2(g) + Na_2S_2O_3(aq)$

e. $Cu(s) + 2H_2SO_4(aq) \rightarrow CuSO_4(aq) + SO_2(g) + 2H_2O(l)$

f. $MnO_2(s) + 4HCl(aq) \rightarrow MnCl_2(aq) + Cl_2(g) + 2H_2O(l)$

g. $As_2O_3(s) + 6KI(aq) + 6HCl(aq) \rightarrow 2AsI_3(s) + 6KCl(aq) + 3H_2O(l)$

h. $2Na_2S_2O_3(aq) + I_2(aq) \rightarrow Na_2S_4O_6(aq) + 2NaI(aq)$