Unit VII Answers

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1. A chemical reaction is process where one or more substances are changed into something new, something that has different chemical properties.

5. $C_3H_8 + O_2 \rightarrow CO_2 + H_2O$

6. $C_3H_{8\,(g)} + O_{2\,(g)} \rightarrow CO_{2\,(g)} + H_2O_{\,(l)}$

7. The reaction uses manganese as a catalyst.

8. The + sign is used to represent "reacts with".

9. silicon tetrachloride + magnesium → silicon + magnesium chloride; $SiCl_{4\,(g)} + Mg_{(s)} \rightarrow Si_{(s)} + MgCl_{2\,(s)}$

10. magnesium + oxygen → magnesium oxide; $Mg_{(s)} + O_{2\,(g)} \rightarrow MgO_{(s)}$

17. a) Solid zinc reacts with a solution of hydrogen chloride to produce a solution of zinc chloride and hydrogen gas.

    b) Calcium chloride and sodium carbonate, both in water solution, react to form solid calcium carbonate and a solution of sodium chloride.

    c) A solution of sodium hydroxide reacts with a solution of hydrogen chloride to produce a solution containing sodium chloride and water.

    d) Heating solid calcium carbonate produces solid calcium oxide and carbon dioxide gas.

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4. a) potassium chlorate → potassium chloride and oxygen $KClO_3 \rightarrow KCl + O_2$ $2KClO_3 \rightarrow 2KCl + 3O_2$

   b) silver and sulfur → silver sulfide $Ag + S_8 \rightarrow Ag_2S$ $16Ag + S_8 \rightarrow 8Ag_2S$

   c) sodium hydrogen carbonate → sodium carbonate + carbon dioxide + water
   $NaHCO_3 \rightarrow Na_2CO_3 + CO_2 + H_2O$ $2NaHCO_3 \rightarrow Na_2CO_3 + CO_2 + H_2O$

5. a) $2ZnS + 3O_2 \rightarrow 2ZnO + 2SO_2$ b) $Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$

   c) $3AgNO_3 + AlCl_3 \rightarrow 3AgCl + Al(NO_3)_3$ d) $Ni(ClO_3)_2 \rightarrow NiCl_2 + 3O_2$

6. a) $(NH_4)_2Cr_2O_7 \rightarrow Cr_2O_3 + N_2 + 4H_2O$ b) $2NH_3 + 3CuO \rightarrow N_2 + 3Cu + 3H_2O$

   c) $Na_2SiF_6 + 4Na \rightarrow Si + 6NaF$ d) $2C_4H_{10} + 13O_2 \rightarrow 8CO_2 + 10H_2O$

9. $2H_2 + O_2 \rightarrow 2H_2O$ (2 mole)(2.02 g/mole) + 1 mole (31.998 g/mole) = 2 mole (18.02 g/mole)

10. The correct formula for chlorine is Cl_2 not Cl_3. $2Fe_{(s)} + 3Cl_{2\,(g)} \rightarrow 2FeCl_{3\,(s)}$

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8. a) $Cl_{2\,(g)} + 2\,NaBr_{(aq)} \rightarrow 2NaCl_{(aq)} + Br_{2\,(l)}$ displacement

b) $CaO_{(s)} + H_2O_{(l)} \rightarrow Ca(OH)_{2\,(aq)}$ synthesis

c) $Ca(ClO_3)_{2\,(s)} \rightarrow CaCl_{2\,(s)} + 3O_{2\,(g)}$ decomposition

d) $2AgNO_{3\,(aq)} + K_2SO_{4\,(aq)} \rightarrow Ag_2SO_{4\,(s)} + 2KNO_{3\,(aq)}$ double displacement

e) $Zn_{(s)} + CuBr_{2\,(aq)} \rightarrow ZnBr_{2\,(aq)} + Cu_{(s)}$ displacement

f) $2C_8H_{18\,(l)} + 25O_{2\,(g)} \rightarrow 16CO_{2\,(g)} + 18H_2O_{(g)}$ combustion

9. a) no reaction

b) $Mg_{(s)} + Cu(NO_3)_{2\,(aq)} \rightarrow Cu_{(s)} + Mg(NO_3)_{2\,(aq)}$

c) $4Al_{(s)} + 3O_{2\,(g)} \rightarrow 2Al_2O_{3\,(s)}$

d) $H_2SO_{4\,(aq)} + 2KOH_{(aq)} \rightarrow K_2SO_{4\,(aq)} + 2H_2O_{(l)}$

10. a) $2HgO \rightarrow 2Hg + O_2$ decomposition

b) $2C_3H_7OH + 9O_2 \rightarrow 6CO_2 + 8H_2O$ combustion

c) $Zn + CuSO_4 \rightarrow Cu + ZnSO_4$ displacement

d) $BaCl_2 + Na_2SO_4 \rightarrow NaCl + BaSO_4$ double displacement

e) $Zn + F_2 \rightarrow ZnF_2$ synthesis

f) $2C_5H_{10} + 15O_2 \rightarrow 10CO_2 + 10H_2O$ combustion

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6. a) $Br_{2\,(l)} + 2Na^+_{(aq)} + 2I^-_{(aq)} \rightarrow 2Na^+_{(aq)} + 2Br^-_{(aq)} + I_{2\,(s)}$

b) $Ca^{2+}_{(aq)} + 2OH^-_{(aq)} + 2H^+_{(aq)} + 2Cl^-_{(aq)} \rightarrow Ca^{2+}_{(aq)} + 2Cl^-_{(aq)} + 2H_2O_{(l)}$

c) $Mg_{(s)} + 2Ag^+_{(aq)} + 2NO_3^-{}_{(aq)} \rightarrow 2Ag_{(s)} + Mg^{2+}_{(aq)} + 2NO_3^-{}_{(aq)}$

d) $Ag^+_{(aq)} + NO_3^-{}_{(aq)} + K^+_{(aq)} + Br^-_{(aq)} \rightarrow AgBr_{(s)} + K^+_{(aq)} + NO_3^-{}_{(aq)}$

e) $Ni_{(s)} + Pb^{2+}_{(aq)} + 2NO_3^-{}_{(aq)} \rightarrow Ni^{2+}_{(aq)} + 2NO_3^-{}_{(aq)} + Pb_{(s)}$

f) $Ca_{(s)} + 2H_2O_{(l)} \rightarrow Ca^{2+} + 2OH^-_{(aq)} + H_{2\,(g)}$

7. a) $Br_{2\,(l)} + 2I^-_{(aq)} \rightarrow 2Br^-_{(aq)} + I_{2\,(s)}$ Spectator ion: sodium ion

b) $2OH^-_{(aq)} + 2H^+_{(aq)} \rightarrow 2H_2O_{(l)}$ Spectator ion: calcium and chloride ions

c) $Mg_{(s)} + 2Ag^+_{(aq)} \rightarrow 2Ag_{(s)} + Mg^{2+}_{(aq)}$ Spectator ion: nitrate ion

d) $Ag^+_{(aq)} + K^+_{(aq)} + Br^-_{(aq)} \rightarrow AgBr_{(s)} + K^+_{(aq)}$ Spectator ion: nitrate ion

e) $Ni_{(s)} + Pb^{2+}_{(aq)} \rightarrow Ni^{2+}_{(aq)} + Pb_{(s)}$ Spectator ion: nitrate ion

f) $Ca_{(s)} + 2H_2O_{(l)} \rightarrow Ca^{2+} + 2OH^-_{(aq)} + H_{2\,(g)}$ Spectator ion: none

8. a) $Au^{+3}_{(aq)} + 3Cl^-_{(aq)} + 3Ag_{(s)} \rightarrow Au_{(s)} + 3AgCl_{(s)}$

b) $2Ag^+_{(aq)} + 2NO_3^-{}_{(aq)} + Ca^{2+}_{(aq)} + 2Cl^-_{(aq)} \rightarrow 2AgCl_{(s)} + Ca^{2+}_{(aq)} + 2NO_3^-{}_{(aq)}$

c) $2Al_{(s)} + 3Ni^{2+}_{(aq)} + 3SO_4^{2-}{}_{(aq)} \rightarrow 3Ni_{(s)} + 2Al^{3+}_{(aq)} + 3SO_4^{2-}{}_{(aq)}$

d) $2Na_{(s)} + 2H_2O_{(l)} \rightarrow 2Na^+_{(aq)} + 2OH^-_{(aq)} + H_{2\,(g)}$

e) $Ag^+_{(aq)} + NO_3^-{}_{(aq)} + Na^+_{(aq)} + Cl^-_{(aq)} \rightarrow AgCl_{(s)} + Na^+_{(aq)} + NO_3^-{}_{(aq)}$

9. a) $Au^{+3}_{(aq)} + 3Cl^-_{(aq)} + 3Ag_{(s)} \rightarrow Au_{(s)} + 3AgCl_{(s)}$ Spectator ion: none

b) $Ag^+_{(aq)} + Cl^-_{(aq)} \rightarrow AgCl_{(s)}$ Spectator ion: nitrate and calcium ions

c) $2Al_{(s)} + 3Ni^{2+}_{(aq)} \rightarrow 3Ni_{(s)} + 2Al^{3+}_{(aq)}$ Spectator ion: sulfate ion

d) $2Na_{(s)} + 2H_2O_{(l)} \rightarrow 2Na^+_{(aq)} + 2OH^-_{(aq)} + H_{2\,(g)}$ Spectator ion: none

e) $Ag^+_{(aq)} + Cl^-_{(aq)} \rightarrow AgCl_{(s)}$ Spectator ion: nitrate and sodium ions

10. a) $2Ag^+_{(aq)} + 2NO_3^-{}_{(aq)} + 2Na^+_{(aq)} + SO_4^{2-}{}_{(aq)} \rightarrow 2Na^+_{(aq)} + 2NO_3^-{}_{(aq)} + Ag_2SO_{4\,(s)}$

b) $2Al_{(s)} + 3Ni^{2+}_{(aq)} + 6I^-_{(aq)} \rightarrow 3Ni_{(s)} + 2Al^{3+}_{(aq)} + 6I^-_{(aq)}$

c) $2K^+_{(aq)} + SO_4^{2-}{}_{(aq)} + Ca^{2+}_{(aq)} + 2Cl^-_{(aq)} \rightarrow CaSO_{4\,(s)} + 2K^+_{(aq)} + 2Cl^-_{(aq)}$

d) $Mg_{(s)} + Cu^{2+}_{(aq)} + 2Br^-_{(aq)} \rightarrow Cu_{(s)} + Mg^{2+}_{(aq)} + 2\,Br^-_{(aq)}$

e) $Pb^{2+}_{(aq)} + 2NO_3^-{}_{(aq)} + 2Na^+_{(aq)} + 2Cl^-_{(aq)} \rightarrow PbCl_{2\,(s)} + 2Na^+_{(aq)} + 2NO_3^-{}_{(aq)}$

11. a) $2Ag^+_{(aq)} + SO_4^{2-}{}_{(aq)} \rightarrow Ag_2SO_{4\,(s)}$ Spectator ion: nitrate and sodium ions

b) $2Al_{(s)} + 3Ni^{2+}_{(aq)} \rightarrow 3Ni_{(s)} + 2Al^{3+}_{(aq)}$ Spectator ion: iodide ion

c) $SO_4^{2-}{}_{(aq)} + Ca^{2+}_{(aq)} \rightarrow CaSO_{4\,(s)}$ Spectator ion: potassium and chloride ions

d) $Mg_{(s)} + Cu^{2+}_{(aq)} \rightarrow Cu_{(s)} + Mg^{2+}_{(aq)}$ Spectator ion: bromide ion

e) $Pb^{2+}_{(aq)} + 2Cl^-_{(aq)} \rightarrow PbCl_{2\,(s)}$ Spectator ion: nitrate and sodium ions

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31. a) $H_2 + Cl_2 \rightarrow 2HCl$

b) $2Al + Fe_2O_3 \rightarrow 2Fe + Al_2O_3$

c) $Ba(ClO_3)_2 \rightarrow BaCl_2 + 3O_2$

d) $3Cu + 8HNO_3 \rightarrow 3Cu(NO_3)_2 + 2NO + 4H_2O$

32. a) $Fe_2O_3 + 3Mg \rightarrow 3MgO + 2Fe$

b) $3NO_2 + H_2O \rightarrow 2HNO_3 + NO$

c) $SiCl_4 + 2H_2O \rightarrow SO_2 + 4HCl$ d) $(NH_4)_2Cr_2O_7 \rightarrow N_2 + Cr_2O_3 + 4H_2O$

33. a) $4Fe + 3O_2 \rightarrow 2Fe_2O_3$ b) $2H_2O_2 \rightarrow 2H_2O + O_2$

c) $2C_8H_{18} + 25O_2 \rightarrow 16CO_2 + 18H_2O$ d) $2Al + 3F_2 \rightarrow 2AlF_3$

34. a) $2C_3H_7OH + 9O_2 \rightarrow 6CO_2 + 8H_2O$ b) $2Al + 3Fe(NO_3)_2 \rightarrow 2Al(NO_3)_3 + 3Fe$

c) $2Fe(OH_3) \rightarrow 2Fe_2O_3 + 3H_2O$ d) $2PbO_2 \rightarrow 2PbO + O_2$

35. a) $Zn + Pb(NO_3)_2 \rightarrow Pb + Zn(NO_3)_2$ b) $NH_4CH_3COO + AgNO_3 \rightarrow NH_4NO_3 + AgCH_3COO$

c) $H_2C_2O_4 + 2NaOH \rightarrow Na_2C_2O_4 + 2\ HOH$ d) $2Al + 3CuSO_4 \rightarrow Al_2(SO_4)_3 + 3Cu$

36. a) $CuSO_4 + (NH_4)_2S \rightarrow CuS + (NH_4)_2SO_4$ b) $2HNO_3 + Ba(OH)_2 \rightarrow Ba(NO_3)_2 + 2HOH$

c) $Fe(NO_3)_3 + 3LiOH \rightarrow 3LiNO_3 + Fe(OH)_3$ d) $3BaCl_2 + 3H_3PO_4 \rightarrow Ba_3(PO_4)_2 + 6HCl$

37. a) $2Zn + O_2 \rightarrow 2ZnO$ b) $F_2 + Mg \rightarrow MgF_2$

c) $Cl_2 + 2K \rightarrow 2KCl$ d) $H_2 + I_2 \rightarrow 2HI$

38. a) $2HgO \rightarrow 2Hg + O_2$ b) $2H_2O \rightarrow 2H_2 + O_2$

c) $2AgCl \rightarrow 2Ag + Cl_2$ d) $2KOH \rightarrow K_2O + H_2O$

39. a) $2C_3H_6 + 9O_2 \rightarrow 6CO_2 + 6H_2O$ b) $C_5H_{12} + 8O_2 \rightarrow 5CO_2 + 6H_2O$

c) $2CH_3OH + 3O_2 \rightarrow 2CO_2 + 4H_2O$ d) $C_{12}H_{22}O_{11} + 12O_2 \rightarrow 12CO_2 + 11H_2O$

40. a) $C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$ combustion b) $CuCl_2 \rightarrow Cu + Cl_2$ decomposition

c) $2Mg + O_2 \rightarrow 2MgO$ synthesis d) $Na_2CO_3 \rightarrow Na_2O + CO_2$ decomposition

e) $Ba(OH)_2 \rightarrow BaO + H_2O$ decomposition f) $C_2H_5 + 3O_2 \rightarrow 2CO_2 + 3\ H_2O$ combustion

46. a) $H^+_{(aq)} + Cl^-_{(aq)} + Na^+_{(aq)} + OH^-_{(aq)} \rightarrow Na^+_{(aq)} + Cl^-_{(aq)} + H_2O_{(l)}$
$H^+_{(aq)} + OH^-_{(aq)} \rightarrow H_2O_{(l)}$

b) $Mg_{(s)} + 2H^+_{(aq)} + 2Cl^-_{(aq)} \rightarrow Mg^{2+}_{(aq)} + 2Cl^- + H_{2\,(g)}$
$Mg_{(s)} + 2H^+_{(aq)} \rightarrow Mg^{2+}_{(aq)} + H_{2\,(g)}$

c) $Cd^{2+}_{(aq)} + 2Cl^-_{(aq)} + 2Na^+_{(aq)} + CO_3{}^{2-}_{(aq)} \rightarrow CdCO_{3\,(s)} + 2Na^+_{(aq)} + 2Cl^-_{(aq)}$
$Cd^{2+}_{(aq)} + CO_3{}^{2-}_{(aq)} \rightarrow CdCO_{3\,(s)}$

d) $Mg_{(s)} + Zn^{2+}_{(aq)} + 2NO_3{}^-_{(aq)} \rightarrow Zn_{(s)} + Mg^{2+}_{(aq)} + 2NO_3{}^-_{(aq)}$
$Mg_{(s)} + Zn^{2+}_{(aq)} \rightarrow Zn_{(s)} + Mg^{2+}_{(aq)}$

47. a) sodium and chloride ions b) chloride ion c) sodium and chloride ions d) nitrate ion

48. a) $CO_3^{2-}{}_{(aq)} + Ca^{2+}{}_{(aq)} \rightarrow CaCO_{3\,(s)}$ b) $SO_4^{2-}{}_{(aq)} + 2Ag^{+}{}_{(aq)} \rightarrow Ag_2SO_{4\,(s)}$

c) $Cl^{-}{}_{(aq)} + Ag^{+}{}_{(aq)} \rightarrow AgCl_{(s)}$ d) No Reaction

51. a) $CaH_{2\,(s)} + 2H_2O_{(l)} \rightarrow Ca(OH)_{2\,(aq)} + 2H_{2\,(g)}$ b) $CH_3CH_2CCH_{(g)} + 2Br_{2\,(l)} \rightarrow CH_3CH_2\,CHBr_{2\,(l)}$

c) $Pb^{2+}{}_{(aq)}\,2OH^{-}{}_{(aq)} \rightarrow Pb(OH)_{2\,(s)}$ d) $3NO_{2\,(g)} + H_2O_{(l)} \rightarrow 2HNO_{3\,(aq)} + NO_{(g)}$

52. a) $H_2 + I_2 \rightarrow 2HI$ synthesis b) $2Li + 2HOH \rightarrow 2LiOH + H_2$ displacement

c) $2HgO \rightarrow 2Hg + O_2$ decomposition d) $Cu + Cl_2 \rightarrow CuCl_2$ synthesis

53. a) $H_2O_{(g)} + C_{(s)} \rightarrow CO_{(g)} + H_{2\,(g)}$ b) $NH_4NO_{3\,(aq)} \rightarrow N_2O_{(g)} + 2H_2O_{(l)}$

c) $2NO_{(g)} + O_{2\,(g)} \rightarrow 2NO_{2\,(g)}$

54. a) $CO_{(g)} + 2H_{2\,(g)} \rightarrow CH_3OH_{(l)}$ b) $2CH_3OH + 3O_2 \rightarrow 2CO_2 + 4H_2O$

55. a) not possible, nickel is below magnesium in the activity series
b) possible, magnesium is above aluminum in the activity series
c) not possible, lead does not react with water

56. The correct equation is “b”. In “a” the formula for chlorine is incorrect and in “c” the formula for iron (III) chloride is incorrect.

57. a) $C_3H_8 + 5O_2 \rightarrow 3CO_2 + 4H_2O$ b) $MgCO_3 \rightarrow MgO + CO_2$

c) $Pt + 2F_2 \rightarrow PtF_4$ d) $Zn + Pb(NO_3)_2 \rightarrow Pb + Zn(NO_3)_2$

58. a) $Li_2CO_{3\,(aq)} + BaBr_{2\,(aq)} \rightarrow BaCO_{3\,(s)} + 2LiBr_{(aq)}$
$2Li^{+}{}_{(aq)} + CO_3^{2-}{}_{(aq)} + Ba^{2+}{}_{(aq)} + 2Br^{-}{}_{(aq)} \rightarrow BaCO_{3\,(s)} + 2Li^{+}{}_{(aq)} + 2Br^{-}{}_{(aq)}$
$CO_3^{2-}{}_{(aq)} + Ba^{2+}{}_{(aq)}\,) \rightarrow BaCO_{3\,(s)}$

b) $Na_2SO_{4\,(aq)} + Sr(NO_3)_{2\,(aq)} \rightarrow SrSO_{4\,(s)} + 2NaNO_{3\,(aq)}$
$2Na^{+}{}_{(aq)} + SO_4^{2-}{}_{(aq)} + Sr^{2+}{}_{(aq)} + 2NO_3^{-}{}_{(aq)} \rightarrow SrSO_{4\,(s)} + 2Na^{+}{}_{(aq)} + 2NO_3^{-}{}_{(aq)}$
$SO_4^{2-}{}_{(aq)} + Sr^{2+}{}_{(aq)}\,) \rightarrow SrSO_{4\,(s)}$

c) $2Al_{(s)} + 3NiCl_{2\,(aq)} \rightarrow 3Ni_{(s)} + 2AlCl_{3\,(aq)}$
$2Al_{(s)} + 3Ni^{2+}{}_{(aq)} + 6Cl^{-}{}_{(aq)} \rightarrow 3Ni_{(s)} + 2Al^{3+}{}_{(aq)} + 6Cl^{-}{}_{(aq)}$
$2Al_{(s)} + 3Ni^{2+}{}_{(aq)} \rightarrow 3Ni_{(s)} + 2Al^{3+}{}_{(aq)}$

d) $3K_2CO_{3\,(aq)} + 2FeCl_{3\,(aq)} \rightarrow 6KCl_{(aq)} + Fe_2(CO_3)_{3\,(s)}$
$6K^{+}{}_{(aq)} + 3CO^{2-}{}_{(aq)} + 2Fe^{3+}{}_{(aq)} + 6Cl^{-}{}_{(aq)} \rightarrow 6K^{+}{}_{(aq)} + 6Cl^{-}{}_{(aq)} + Fe_2(CO_3)_{3\,(s)}$
$3CO^{2-}{}_{(aq)} + 2Fe^{3+}{}_{(aq)} \rightarrow Fe_2(CO_3)_{3\,(s)}$

59. a) Li^{+} and Br^{-} b) Na^{+} and NO_3^{-} c) Cl^{-} d) K^{+} and Cl^{-}

60. a) The formula of the product is incorrect: $4Li + O_2 \rightarrow 2Li_2O$

b) A ternary compound does not break into its elements. Carbonates decompose to form carbon dioxide $MgCO_3 \rightarrow MgO + CO_2$

c) Chlorine atoms are not balanced and iodine is diatomic. $2NaI + Cl_2 \rightarrow 2NaCl + I_2$

d) The formulas for the products are incorrect. $2AgNO_3 + CaCl_2 \rightarrow 2AgCl + Ca(NO_3)_2$

e) Magnesium should take the place of iron in the compound $3Mg + 2FeBr_3 \rightarrow 2Fe + 3MgBr_2$

73. fluorine 74. 20 pm

75. The bond length of a single bond with hydrogen increases down the halogen group.

76. The size of a halogen atom increases down the group. Fluorine is the smallest atom and iodine the largest of the four.

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4. a) 5.48 mole BrCl b) 780.0 g BrCl c) 18.3 ml Br_2 d) 1.20×10^4 g Br_2

5. a) 1.42 mole CO_2 b) 47.2 ml CO_2

Pg 319

7. a) $P_4O_{10} + 6H_2O \rightarrow 4H_3PO_4$ b) 138.1 g H_3PO_4 c) 91.4%

8. $TiCL_4$ is limiting; 3.5 mole TiO_2 and 7.0 mole Cl_2 are produced; 1.0 mole O_2 is left over

9. 3.70 g Cu 10. 93.8%

11. a) $Mg + 2HOH \rightarrow Mg(OH)_2 + H_2$ b) 86.8% c) 55 g $Mg(OH)_2$

12. a) CuO is limiting b) 94.3% c) 15.0 g Cu

Pgs 329-334

6. The balanced chemical equation relates the relative amounts of the reactants and products in moles. To determine the amounts of substances one needs to use the coefficients of the balanced equation.

7. The mole ratio indicated by the coefficients in the balanced equation.

8. The purpose is to change the formula, the kind of substance.

9. The coefficients give the mole ratio of the balanced equation. This ratio is needed to determine the amount of one substance that will react or produce the required amount of another substance.

27. a) 6.6 mole H_2 b) 3.36 mole O_2 c) 8.12 mole H_2

28. a) 1.63×10^3 mole H_2O b) 2.90×10^3 mole N_2H_4 c) 6.39×10^3 mole N_2

29. a) 1.08 mole O_2 b) 2.62 mole Al_2O_3 c) 1.99 mole Al_2O_3

30. a) 273 g H_2O b) 58.1 g CaC_2 c) 269 g H_2O

31. a) 49.0 g O_2 b) 748 g $KClO_3$ c) 12.7 g KCl

32. 73.3 g Al_2O_3 33. 107 g O_2

34. a) 1.68 L O_2 b) 0.153 g $KClO_3$ c) 1.51 x 10^4 mL O_2

35. a) 113 L O_2 b) 25 L O_2 c) 7.41 L O_2

36. a) 1.34 x 10^{24} molecules NO_2 b) 9.67 x 10^{23} molecules NO c) 1.88 x 10^{23} molecules O_2

37. a) 4.61 x 10^{23} molecules H_2 b) 4.31 x 10^{23} atoms Na c) 3.30 x 10^{23} molecules H_2

38. a) excess, O_2; limiting NO b) 4.0 mole NO_2

39. a) excess, H_2O; limiting CaC_2 b) 26 g C_2H_2 c) 74 g $Ca(OH)_2$

40. a) excess, H_2; limiting N_2 b) 34 g NH_3 c) 22 g H_2

41. 75.6%

54. a) 1.2 x 10^2 g CO_2 b) 9.70 mL H_2O c) 4.49 x 10^{22} molecules H_2O

55. a) $\frac{2 \text{ mole } NaN_3}{2 \text{ mole Na}}$ $\frac{2 \text{ mole } NaN_3}{3 \text{ mole } N_2}$ $\frac{2 \text{ mole Na}}{2 \text{ mole } NaN_3}$ $\frac{2 \text{ mole Na}}{3 \text{ mole } N_2}$ $\frac{3 \text{ mole } N_2}{2 \text{ mole } NaN_3}$ $\frac{3 \text{ mole } N_2}{2 \text{ mole Na}}$

b) 4.0 mole N_2 c) 11.0 g Na d) 4.86 x 10^{23} molecules N_2

56. a) NO b) 84 g NO_2 c) 37%

57. 1.44 L N_2 58. 8.6 x 10^3 g HNO_3 59. 1.74 x 10^3 g CO_2

Pg 611

1. Oxidation is the loss of electrons, reduction is the gain of electrons LEO the lion says GER.

2. If the oxidation number of an element changes it is a redox reaction.

3. The half reactions show the electron change. To balance an equation the number of electrons lost must equal the number of electrons gained. Writing half reactions helps to determine the electron transfer.

4. The number of electrons lost must be equal to the number gained.

5. An oxidizing agent is something that takes electrons away from another substance, in the process it is reduced. A reducing agent is something that gives electrons to another substance, in the process it is oxidized.

6. a) H=+1, S=+4, O=-2 b) Cl=0 c) S=+6, F=-1 d) N=+5, O=-2

7. a) C=-4, H=+1 b) H=+1, S=+4, O=-2 c) Na=+1, H=+1, O=-2 d) Na=+1, Bi=+5, O=-2

8. CrO_3 +6, CrO +2, $Cr_{(s)}$ 0, CrO_2 +4, Cr_2O_3 +3, $Cr_2O_7^{2-}$ +6, CrO_4^{2-} +6

9. a) not redox
   b) O is oxidized (from –2 to 0), NO_3^- is the reducing agent, N is reduced (from +5 to +3) NO_3^- is the oxidizing agent
   c) H is oxidized (from 0 to +1) H_2 is the reducing agent, Cu is reduced (from +2 to 0) Cu^{2+} is the oxidizing agent
   d) not redox
   e) H is oxidized (from 0 to +1) H_2 is the reducing agent, Cl is reduced (from 0 to –1) Cl_2 is the oxidizing agent
   f) not redox

10. a) $6Cl^-_{(aq)} + Cr_2O_7^{2-}{}_{(aq)} + 14H_3O^+_{(aq)} \rightarrow 3Cl_{2\,(g)} + 2Cr^{3+}_{(aq)} + 21H_2O_{(l)}$

    b) $Cu_{(s)} + 2Ag^+_{(aq)} \rightarrow Cu^{2+}_{(aq)} + 2Ag_{(s)}$

    c) $Br_{2\,(l)} + 2I^-_{(aq)} \rightarrow 2Br^-_{(aq)} + I_{2\,(s)}$

    d) $2I^-_{(aq)} + 2NO_2^-{}_{(aq)} + 4H_3O^+_{(aq)} \rightarrow I_{2\,(s)} + 2NO_{(g)} + 6H_2O_{(l)}$

11. a) Cl is oxidized, Cl^- is the reducing agent. Cr is reduced, $Cr_2O_7^{2-}$ is the oxidizing agent.

    b) Cu is oxidized, Cu is the reducing agent. Ag is reduced, Ag^+ is the oxidizing agent

    c) I is oxidized, I^- is the reducing agent. Br is reduced , $Br_2$is the oxidizing agent.

    d) I is oxidized, I^- is the reducing agent. N is reduced, NO_2^- is the oxidizing agent.

Pg 615

1. The potential difference or electromotive force is measured in volts.

2. A voltage is needed for electrons to move from one place to another.

3. Anode – attracts anions, where oxidation occurs; Cathode – attracts cations, where reduction occurs; wires are the path for electrons; the electrolyte is the path for the ions; salt bridge to keep electrolytes from mixing.

4. See #3

9. No light, the electrons would be pushed against each other.

10. The flashlight would probably work (if it is not an LED flashlight), the path of the electrons would be reversed.

Pg 624

3. Zinc will corrode the easiest because it has the most negative electrode potential

5. +1.136 volts 6. +0.066 volts

7. $Pb_{(s)} + PbO_{2\,(s)} + 2H_3O^+_{(aq)} + 2HSO_4^-{}_{(aq)} \rightarrow 2PbSO_{4\,(s)} + 4H_2O_{(l)}$ Sulfuric acid is consumed and water is produced so the sulfuric acid concentration decreases as the battery is discharged. As the concentration of sulfuric acid decreases so does the density so the charge level is indicated by the density of the solution.

Pgs 634-638

39. C=+4, O=-2
40. Co=+2, O=-2
41. Ba=+2, Cl=-1
42. K=+1, S=+6, O=-2
43. S=-2
44. La=+3
45. C=-4, H=+1
46. N=-3, H=+1
47. Ca=+2, C=+4, O=-2
48. Pt=+4, Cl=-1
49. C=+4, O=-2, Cl=-1
50. P=+5, O=-2
51. $Fe_{(s)} \rightarrow Fe^{2+}_{(aq)} + 2e^-$
52. $Cl_{2\,(g)} + 2e^- \rightarrow 2Cl^-_{(aq)}$
53. $Fe_{(s)} + Cl_{2\,(g)} \rightarrow Fe^{2+}_{(aq)} + 2Cl^-_{(aq)}$
54. $2HOBr_{(aq)} + 2H_3O^+ + 2e^- \rightarrow 2Br_{2\,(l)} + 4H_2O_{(l)}$
55. $6H_2O_{(l)} \rightarrow O_{2\,(g)} + 4H_3O^+_{(aq)} + 4e^-$
56. $4HOBr_{(aq)} \rightarrow O_{2\,(g)} + 2Br_{2\,(l)} + 2H_2O_{(l)}$
57. $O_{2\,(g)} + 4H_3O^+_{(aq)} + 4e^- \rightarrow 6H_2O_{(l)}$
58. $5H_2O_{(l)} + SO_{2\,(aq)} \rightarrow HSO_4^-{}_{(aq)} + 3H_3O^+_{(aq)} + 2e^-$
59. $4H_2O_{(l)} + 2SO_{2\,(aq)} + O_{2\,(g)} \rightarrow 2HSO_4^-{}_{(aq)}\ 2H_3O^+_{(aq)}$
60. $Zn_{(s)} + 2F^{3+}_{(aq)} \rightarrow Zn^{3+}{}_{)aq)} + 2Fe^{2+}_{(aq)}$
61. +0.85 volts
63. 0.222 volts
64. +1.174 volts
65. 1.229 volts