Some symbols are derived from non-English words. i.e., Latin, Greek, or German names.

Fe	(ferrum)	iron	Cu	(cuprum)	copper
Na	(natrium)	sodium	K	(kalium)	potassium
Ag	(argentum)	silver	Hg	(hydrargyrum)	mercury
Sn	(stannum)	tin	Sb	(stibium)	antimony
Pb	(plumbum)	lead	Au	(aurium)	gold
W	(wolfram)	tungsten			

Symbols are used as a sort of shorthand in writing the names of elements. The use of symbols to represent atoms, or definite quantities by mass of the elements is also important in writing chemical formulas and in describing reactions. Thus, the symbol C represents the element carbon, but it also represents one atom of carbon. ***Note:*** The first letter of the symbol is **always** printed uppercase; the second letter is **always** printed lowercase!

Fill in the blanks given above with the names of the elements the symbols represent. Be able to give either the symbol or its name from memory.

Teacher Notes on Chapter 2

The material covered in this chapter should be a review of binary nomenclature from first year chemistry. The key here is for the student to determine if the binary compound in question is composed of two nonmetals (molecular) or a metal and a nonmetal (ionic). Binary molecular compounds use prefixes; ionic compounds (salts) do not. The material in this chapter should be given as an out-of-classroom review assignment.

Answers for the questions at the end of Chapter 2:

Exercise 2–1: In column 1, classify each of the following compounds as binary molecules (M) or binary ionic salts (I). Then in column 2, use the rules to name each binary compound.

1. CaF_2	I	calcium fluoride	10. SrI_2	I	strontium iodide
2. P_4O_{10}	M	tetraphosphorus decaoxide	11. CO	M	carbon monoxide
3. K_2S	I	potassium sulfide	12. Cs_2Po	I	cesium polonide
4. NaH	I	sodium hydride	13. $ZnAt_2$	I	zinc astatide
5. Al_2Se_3	I	aluminum selenide	14. P_2S_3	M	diphosphorus trisulfide
6. N_2O	M	dinitrogen monoxide	15. AgCl	I	silver chloride
7. O_2F	M	dioxygen monofluoride	16. Na_3N	I	sodium nitride
8. SBr_6	M	sulfur hexabromide	17. Mg_3P_2	I	magnesium phosphide
9. Li_2Te	I	lithium telluride	18. XeF_6	M	xenon hexafluoride

Teacher Notes on Chapter 3

Chapter 3 still covers first year material, but the topic is one that many students have difficulty learning and applying properly. Second year chemistry students must be able to determine the oxidation numbers of elements in compounds and free elements, recognize variable oxidation numbers of elements, know formulas and charges and names of common polyatomic ions, and know the formulas of free polyatomic elements. Success in chemistry depends on memorizing the material in this chapter. It is strongly advised that this material be tested no later than the fifth or sixth week of the second year high school chemistry course.

Answers for the questions in Chapter 3:

Exercise 3–1: Determine the oxidation number of each underlined element.

1. $K_2\underline{S}$	2^-	9. $Mg(\underline{B}F_4)_2$	3^+
2. $NaClO_4$	7^+	10. $\underline{Au}_2O_3$	3^+
3. $\underline{Br}Cl$	1^+	11. $\underline{C}_{60}$	0
4. Li_2CO_3	4^+	12. $\underline{Zr}O_2$	4^+
5. OF_2	2^+	13. $\underline{Nb}OF_6^{3-}$	5^+
6. $\underline{S}_8$	0	14. $Al_2(\underline{Cr}O_4)_3$	6^+
7. $\underline{Mg}$	0	15. $Cs_2\underline{Te}F_8$	6^+
8. $K_2\underline{W}_4O_{13}$	6^+		

Exercise 3–2: Name the following substances.

1. $FeSO_3$	iron(II) sulfite	12. $CuCH_3COO$	copper(I) acetate
2. $Cu(NO_3)_2$	copper(II) nitrate	13. N_2O_4	dinitrogen tetraoxide
3. Hg_2Cl_2	mercury(I) chloride	14. Rb_3P	rubidium phosphide
4. AgBr	silver bromide	15. S_8	sulfur
5. $KClO_3$	potassium chlorate	16. Fe_2O_3	iron(III) oxide
6. $MgCO_3$	magnesium carbonate	17. $(NH_4)_2SO_3$	ammonium sulfite
7. BaO_2	barium peroxide	18. $Ca(MnO_4)_2$	calcium permanganate
8. KO_2	potassium superoxide	19. PF_5	phosphorus pentafluoride
9. SnO_2	tin(IV) oxide	20. LiH	lithium hydride
10. $Pb(OH)_2$	lead(II) hydroxide	21. $Ti(HPO_4)_2$	titanium(IV) monohydrogen phosphate
11. $Ni_3(PO_4)_2$	nickel(II) phosphate		

Exercise 3–3: Write formulas for the following substances.

1.	vanadium(V) oxide	V_2O_5	12.	tin(II) carbonate	$SnCO_3$
2.	dihydrogen monoxide	H_2O	13.	sodium hydrogen carbonate	$NaHCO_3$
3.	ammonium oxalate	$(NH_4)_2C_2O_4$	14.	manganese(VII) oxide	Mn_2O_7
4.	polonium(VI) thiocyanate	$Po(SCN)_6$	15.	copper(II) dihydrogen phosphate	$Cu(H_2PO_4)_2$
5.	tetraphosphorus decaoxide	P_4O_{10}			
6.	zinc hydroxide	$Zn(OH)_2$	16.	francium dichromate	$Fr_2Cr_2O_7$
7.	potassium cyanide	KCN	17.	calcium carbide	CaC_2
8.	cesium tartrate	$Cs_2C_4H_4O_6$	18.	mercury(I) nitrate	$Hg_2(NO_3)_2$
9.	oxygen molecule	O_2	19.	cerium(IV) benzoate	$Ce(C_6H_5COO)_4$
10.	mercury(II) acetate	$Hg(CH_3COO)_2$	20.	potassium hydrogen phthalate	$KHC_8H_4O_4$
11.	silver chromate	Ag_2CrO_4			

Teacher Notes on Chapter 4

We are not sure why, but most students seem to have difficulty working with acid nomenclature. Too many students want to use names such as hydrogen sulfate (or hydrogen sulfuric) and hydrogen nitrate (or hydrogen nitric) instead of the correct nomenclature (sulfuric acid and nitric acid). Teach your students that whenever the word acid appears, hydronium ions (hydrogen) are present in an aqueous solution. The word hydrogen is never used as the first word in the name of an acid. HCl aqueous is known as hydrochloric acid, but is referred to as hydrogen chloride gas when it is nonaqueous.

The *Home Base* concept of "-ate" polyatomic ions is something most students seem to be able get a handle on, provided the student has memorized the formulas and charges of the common polyatomic ions (See Chapter 3). As has been stated in earlier *Chapter Notes*, when it comes to learning chemistry, the name of the game is practice, practice, and more practice! Just as in athletics, it takes quality practice time and effort on a regular daily basis in order to become really good at whatever one is trying to accomplish!

Answers for the questions in Chapter 4:

Exercise 4–1: Name the following compounds.

1.	HIO_3	iodic acid	6.	$HAt(aq)$	hydroastatic acid
2.	$NaBrO_2$	sodium bromite	7.	C_6H_5COOH	benzoic acid
3.	$Ca_3(PO_4)_2$	calcium phosphate	8.	$Hg_2(IO)_2$	mercury(I) hypoiodite
4.	HIO_4	periodic acid	9.	H_3PO_3	phosphorous acid
5.	$Fe(IO_2)_3$	iron(III) iodite	10.	NH_4BrO_3	ammonium bromate

Exercise 4–2: Write formulas for the following compounds.

1.	tartaric acid	$H_2C_4H_4O_6$	6.	hypoiodous acid	HIO
2.	calcium hypochlorite	$Ca(ClO)_2$	7.	cyanic acid	$HOCN$ or $HCNO$
3.	hydrotelluric acid	H_2Te	8.	phthalic acid	$H_2C_8H_4O_4$
4.	copper(II) nitrite	$Cu(NO_2)_2$	9.	tin(IV) chromate	$Sn(CrO_4)_2$
5.	carbonic acid	H_2CO_3			

Exercise 4–3: Complete the following table.

Name of Acid	Formula of Acid	Name of Anion
hydrochloric acid	*HCl*	*chloride*
sulfuric acid	H_2SO_4	*sulfate*
hydroiodic acid	*HI*	iodide
sulfurous acid	H_2SO_3	*sulfite*
chlorous acid	$HClO_2$	chlorite
nitric acid	HNO_3	*nitrate*
acetic acid	$HC_2H_3O_2$ *or* CH_3COOH	acetate
hydrobromic acid	HBr	bromide
hydrosulfuric acid	H_2S	*sulfide*
nitrous acid	HNO_2	nitrite
chromic acid	H_2CrO_4	chromate
phosphoric acid	H_3PO_4	*phosphate*

Teacher Notes on Chapter 5

The chapter on coordination chemistry is one that most teachers never quite get to cover in their second year courses. It comes near the end of their textbook along with the topics of nuclear chemistry, organic chemistry, and biochemistry. Complex ions are a whole new ball game for your students. Most second year AP Chemistry students start off the school year knowing little to nothing about such ions. The secret in covering the topic is to spread it out over the entire school year. Feed your students a little bit of information at a time. Doing three to five complex ion laboratory experiments spread over the year will provide a natural forum for some in-depth discussions concerning complex ions. Coordination chemistry nomenclature and formula writing need to be introduced very early in the school year. The rules for the naming and writing of complex ions are very logical and can be learned without too much suffering on the part of students. Lewis Acid–Base Theory is a natural when it comes to discussing complex ions. Qualitative analysis and bonding theories also fit nicely into this topic.

Have your students do Exercises 5–1 and 5–2 for practice. Additional practice problems can be found in just about any college freshman General Chemistry textbook. Exercise 5–3, Formula Writing Challenge, is provided as an optional assignment to give to your students. Notice that both the reproducible student pages for Exercise 5–3 and the teacher answer key are given in this chapter of the teacher book. Exercise 5–3 is not provided in the student book so that you may decide how to use it. For additional practice, Chapter 13 in this book goes into some elementary complex ion reactions. Such reactions do appear on the AP Chemistry Examination.

Answers for the questions in Chapter 5:

Exercise 5–1: Name the following.

1. $[Ag(NH_3)_2]Cl$	diamminesilver chloride
2. $(NH_4)_3\ [Fe(SCN)_6]$	ammonium hexathiocyanatoferrate(III)
3. $Na_2\ [Ni(CN)_4]$	sodium tetracyanonickelate(II)
4. $[Fe(ox)_3]^{3-}$	tris(oxalato)ferrate(III)
5. $[Co(NH_3)_6]\ Br_2$	hexaamminecobalt(II) bromide
6. $[Cr(H_2O)_4Cl_2]\ Cl$	tetraaquodichlorochromium(III) chloride
7. $[Pt(NH_3)_2]Cl_2$	diammineplatinum(II) chloride
8. $K_2\ [Cu(CN)_4]$	potassium tetracyanocuprate(II)
9. $[Cr(H_2O)_6]\ (NO_3)_3$	hexaaquochromium(III) nitrate
10. $[Co(en)_3]\ Br_3$	tris(ethylenediamine) cobalt(III) bromide

Exercise 5–2: Write formulas for the following.

1. potassium hexacyanoferrate(III)	$K_3[Fe(CN)_6]$
2. sodium hexafluoroaluminate	$Na_3[AlF_6]$
3. diamminesilver ion	$[Ag(NH_3)_2]^+$
4. tetraamminezinc nitrate	$[Zn(NH_3)_4](NO_3)_2$
5. sodium tetrahydroxochromate(III)	$Na[Cr(OH)_4]$
6. trans-dichlorobis(ethylenediamine)cobalt(III) chloride	trans-$[CoCl_2(en)_2]Cl$
7. hexaammineruthenium(III) tetrachloronickelate(II)	$[Ru(NH_3)_6]_2[NiCl_4]_3$
8. tetraamminecopper(II) pentacyanohydroxoferrate(III)	$[Cu(NH_3)_4]_3[Fe(CN)_5(OH)]_2$
9. sodium tetracyanocadmate	$Na_2[Cd(CN)_4]$
10. diamminezinc iodide	$[Zn(NH_3)_2]I_2$

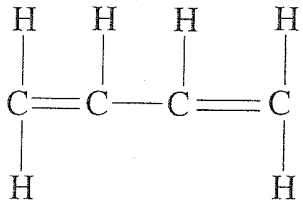
If you have some really bright students in your Advanced Chemistry class, try giving them Exercise 5-3 as a challenge. This is a nice exercise for wrapping up the first five chapters in *The Ultimate Chemical Equations Handbook*. ***Warning:*** Not all names listed are official. Students will have to do some digging into reference sources. This is not an easy assignment.

Teacher Notes on Chapter 6

Although a thorough understanding of Organic Chemistry and its myriad of functional groups and nomenclature is not currently required for the AP Chemistry exam, some knowledge of organic basics can come in handy on the reaction prediction section. Most notably, hydrocarbon combustion equations are not difficult to predict if students are able write formulas for basic alkanes and alcohols. Also, organic compounds are used throughout the exam in various examples. A simple introduction to organic chemistry will familiarize students so that they feel comfortable (and will not avoid) doing problems with an organic basis.

Answers for the questions in Chapter 6:

The structural formula for 1,3-butadiene is



Exercise 6–1: Using condensed formulas provided, name the following hydrocarbon compounds. It may be helpful to draw the structural formula first.

1. $CH_3CH_2CH_2CH(CH_3)CH_3$	2 - methylpentane
2. $CH_3CH(C_2H_5)CH_2CH_3$	3 - methylpentane
3. $CH_3CH_2CHClCH_2CH_2CH_2CH_2Cl$	1,5 - dichloroheptane
4. $CH_3CH_2CH_2CH_2OH$	1 - butanol
5. $CH_3CH_2CH_2CH_2COOH$	pentanoic acid
6. $CH_2=C(CH_3)CH_2CH(CH_3)CH_3$	2,4 - dimethyl - 1 - pentene
7. $(CH_3)_2CHCl$	2 - chloropropane
8. $CH_3C(CH_3)_2CH_2C(CH_3)_2CH_2CH_2CH_3$	2,2,4,4 - tetramethylheptane
9. $CH_3C(CH_3)_2CH=C(CH_3)CH_2CH_3$	2,2,4 - trimethyl - 3 - hexene
10. $CH_3C\equiv CCH_3$	2 - butyne

Exercise 6-2: Draw the condensed formula for each of the following compounds.

1. 2,3 - dimethyl - 2 - butene	$CH_3C(CH_3)=C(CH_3)CH_3$
2. 4 - ethyl - 2 - hexyne	$CH_3C\equiv CCH(C_2H_5)CH_2CH_3$
3. 3,3,6 - trimethylnonane	$CH_3CH_2C(CH_3)_2CH_2CH_2CH(CH_3)CH_2CH_2CH_3$
4. 3 - ethyl - 4 - propylheptane	$CH_3CH_2CH(C_2H_5)CH(C_3H_7)CH_2CH_2CH_3$
5. 3 - octanol	$CH_3CH_2CHOHCH_2CH_2CH_2CH_2CH_3$
6. 2 - methyl - 2 - pentene	$CH_3C(CH_3)=CHCH_2CH_3$
7. 5 - methyl - 1 - hexene	$CH_2=CHCH_2CH_2CH(CH_3)CH_3$
8. 2,2,4,5 - tetramethylhexane	$CH_3C(CH_3)_2CH_2CH(CH_3)CH(CH_3)CH_3$
9. propanoic acid	CH_3CH_2COOH
10. 2 - pentyne	$CH_3C\equiv CCH_2CH_3$

ROUND 1

Exercise 6–3: Predict and balance the following organic reactions.

1. Ethanol (ethyl alcohol) is burned completely in air.
$$C_2H_5OH + 3O_2 \longrightarrow 2CO_2 + 3H_2O$$
2. Propane gas is heated with chlorine gas.
$$C_3H_8 + Cl_2 \longrightarrow C_3H_7Cl + HCl$$
3. Ethanol (ethyl alcohol) and methanoic acid (formic acid) are mixed and warmed.
$$C_2H_5OH + HCOOH \longrightarrow HCOOC_2H_5 + HOH$$
4. Ethene gas is bubbled through a solution of bromine.
$$C_2H_4 + Br_2 \longrightarrow C_2H_4Br_2$$
5. Hydrogen gas is added to 2 - pentene.
$$H_2 + C_5H_{10} \longrightarrow C_5H_{12}$$
6. Octane is burned in oxygen.
$$2C_8H_{18} + 25O_2 \longrightarrow 16CO_2 + 18H_2O$$
7. 2 - butene is combined with hydrogen gas in the presence of a nickel catalyst.
$$C_4H_8 + H_2 \longrightarrow C_4H_{10}$$
8. Ethanoic acid is combined with propanol.
$$CH_3COOH + C_3H_7OH \longrightarrow CH_3COOC_3H_7 + HOH$$
9. An excess of chlorine gas is added to pure ethyne (acetylene) gas.
$$2Cl_2 + C_2H_2 \longrightarrow C_2H_2Cl_4$$
10. A limited amount of liquid bromine is added to an excess of benzene (C_6H_6).
$$Br_2 + C_6H_6 \longrightarrow C_6H_5Br + HBr$$

Teacher Notes on Chapter 7

Balancing equations is hopefully a skill that every student mastered during a first chemistry course. However, a refresher is never a waste of time. Although the reaction prediction section of the AP exam does not require equations to be balanced, students will have to balance equations throughout the multiple choice and free response sections. Indeed, that ability must be a given. In this chapter, reaction prediction exercises focus on relatively simple synthesis and decomposition reactions and writing molecular equations.

Answers for the questions in Chapter 7:

Exercise 7–1: Balance the following equations by adding coefficients as needed. Some equations may already be balanced.

1. $Ca + \underline{2}\,HOH \longrightarrow Ca(OH)_2 + H_2$
2. $Cl_2O_7 + H_2O \longrightarrow \underline{2}HClO_4$
3. $\underline{3}Fe + \underline{2}O_2 \longrightarrow Fe_3O_4$
4. $\underline{2}C_6H_{14} + \underline{19}O_2 \longrightarrow \underline{12}CO_2 + \underline{14}H_2O$
5. $Ca_3(PO_4)_2 + \underline{2}H_2SO_4 \longrightarrow Ca(H_2PO_4)_2 + \underline{2}CaSO_4$
6. $AlCl_3 + \underline{3}AgNO_3 \longrightarrow Al(NO_3)_3 + \underline{3}AgCl$
7. $\underline{2}HCl + CaCO_3 \longrightarrow CO_2 + HOH + CaCl_2$
8. $WO_3 + \underline{3}H_2 \longrightarrow W + \underline{3}H_2O$
9. $Cl_2 + H_2O \longrightarrow HCl + HClO$ *(already balanced)*
10. $Cl_2 + \underline{2}NaI \longrightarrow 2NaCl + I_2$

ROUND 2

Exercise 7–2: Predict and balance the following synthesis and decomposition reactions. Use abbreviations to indicate the phase of reactants and products where possible [i.e., (aq) (s) (l) (g)].

1. A sample of calcium carbonate is heated.

$$CaCO_3(s) \longrightarrow CaO(s) + CO_2(g)$$

2. Sulfur dioxide gas is bubbled through water.

$$SO_2(g) + H_2O(l) \longrightarrow H_2SO_3(aq)$$

3. Solid potassium oxide is added to a container of carbon dioxide gas.

$$K_2O(s) + CO_2(g) \longrightarrow K_2CO_3(s)$$

4. Liquid hydrogen peroxide is warmed.

$$2H_2O_2(l) \longrightarrow 2H_2O(l) + O_2(g)$$

5. Solid lithium oxide is added to water.

$$Li_2O(s) + HOH\ (l) \longrightarrow 2LiOH(aq)$$

6. Molten aluminum chloride is electrolyzed.

$$2AlCl_3(l) \longrightarrow 2Al(l) + 3Cl_2(g)$$

7. A pea-sized piece of sodium is added to a container of iodine vapor.

$$2Na(s) + I_2(g) \longrightarrow 2NaI(s)$$

8. A sample of carbonic acid is heated.

$$H_2CO_3(aq) \longrightarrow CO_2(g) + H_2O(l)$$

9. A sample of potassium chlorate is heated.

$$2KClO_3(s) \longrightarrow 2KCl(s) + 3O_2(g)$$

10. Solid magnesium oxide is added to sulfur trioxide gas.

$$MgO(s) + SO_3(g) \longrightarrow MgSO_4(s)$$

Answers for the questions in Chapter 8:

ROUND 3

Exercise 8–1: Using the activity series, predict and balance the following single replacement reactions. Use abbreviations to indicate the appropriate phase of reactants and products where possible.

Note: Not all of the reactions will occur. For those that do not, write *no reaction*.

1. A piece of copper is dropped into a container of water.

   No reaction

2. Liquid bromine is added to a container of sodium iodide crystals.

   $$Br_2(l) + 2NaI(s) \longrightarrow 2NaBr(s) + I_2(s)$$

3. An aluminum strip is immersed in a solution of silver nitrate.

   $$Al(s) + 3AgNO_3(aq) \longrightarrow Al(NO_3)_3(aq) + 3Ag(s)$$

4. Zinc pellets are added to a sulfuric acid solution.

   $$Zn(s) + H_2SO_4(aq) \longrightarrow ZnSO_4(aq) + H_2(g)$$

5. Fluorine gas is bubbled into a solution of aluminum chloride.

   $$3F_2(g) + 2AlCl_3(aq) \longrightarrow 2AlF_3(aq) + 3Cl_2(g)$$

6. Magnesium turnings are added to a solution of lead(II) acetate.

   $$Mg(s) + Pb(C_2H_3O_2)_2(aq) \longrightarrow Mg(C_2H_3O_2)_2(aq) + Pb(s)$$

7. Iodine crystals are added to a solution of sodium chloride.

   No reaction

8. Calcium metal is added to a solution of nitrous acid.

   $$Ca(s) + 2HNO_2(aq) \longrightarrow Ca(NO_2)_2(aq) + H_2(g)$$

9. A pea-sized piece of lithium is added to water.

   $$2Li(s) + 2HOH(l) \longrightarrow 2LiOH(aq) + H_2(g)$$

10. A solution of iron(III) chloride is poured over a piece of platinum wire.

    No reaction

Answers for the questions in Chapter 9:

ROUND 4

Exercise 9–1: Predict and balance the following metathesis reactions based on the solubility of the products. Use the abbreviations (aq) and (s) for the reactants and products. All reactants are aqueous. *Note:* Some of these reactions do not go to completion.

1. silver nitrate + potassium chromate

$$2AgNO_3(aq) + K_2CrO_4(aq) \longrightarrow Ag_2CrO_4(s) + 2KNO_3(aq)$$

2. ammonium chloride + cobalt(II) sulfate

$$2NH_4Cl(aq) + CoSO_4(aq) \rightleftharpoons CoCl_2(aq) + (NH_4)_2SO_4(aq)$$

3. lithium hydroxide + sodium chromate

$$2LiOH(aq) + Na_2CrO_4(aq) \rightleftharpoons 2NaOH(aq) + Li_2CrO_4(aq)$$

4. zinc acetate + cesium hydroxide

$$Zn(CH_3COO)_2(aq) + 2CsOH(aq) \longrightarrow Zn(OH)_2(s) + 2CsCH_3COO(aq)$$

5. ammonium sulfide + lead(II) nitrate

$$(NH_4)_2S(aq) + Pb(NO_3)_2(aq) \longrightarrow PbS(s) + 2NH_4NO_3(aq)$$

6. iron(III) sulfate + barium iodide

$$Fe_2(SO_4)_3(aq) + 3BaI_2(aq) \longrightarrow 3BaSO_4(s) + 2FeI_3(aq)$$

7. chromium(III) bromide + sodium nitrate

$$CrBr_3(aq) + 3NaNO_3(aq) \rightleftharpoons 3NaBr(aq) + Cr(NO_3)_3(aq)$$

8. rubidium phosphate + titanium(IV) nitrate

$$4Rb_3PO_4(aq) + 3Ti(NO_3)_4(aq) \longrightarrow 12RbNO_3(aq) + Ti_3(PO_4)_4(s)$$

9. ammonium carbonate + nickel(II) chloride

$$(NH_4)_2CO_3(aq) + NiCl_2(aq) \longrightarrow NiCO_3(s) + 2NH_4Cl(aq)$$

10. tin(IV) nitrate + potassium sulfite

$$Sn(NO_3)_4(aq) + 2K_2SO_3(aq) \longrightarrow Sn(SO_3)_2(s) + 4KNO_3(aq)$$

Exercise 9–2: Predict and balance the following metathesis reactions. Use the abbreviations (s), (l), (g), and (aq) for the reactants and products. All reactants are aqueous unless otherwise stated.

1. ammonium sulfate and potassium hydroxide are mixed together

$$(NH_4)_2SO_4(aq) + 2KOH(aq) \longrightarrow 2NH_3(g) + 2HOH(l) + K_2SO_4(aq)$$

2. ammonium sulfide is reacted with hydrochloric acid

$$(NH_4)_2S(aq) + 2HCl(aq) \longrightarrow H_2S(g) + 2NH_4Cl(aq)$$

3. cobalt(II) chloride is combined with silver nitrate

$$CoCl_2(aq) + 2AgNO_3(aq) \longrightarrow 2AgCl(s) + Co(NO_3)_2(aq)$$

4. solid calcium carbonate is reacted with sulfuric acid

$$CaCO_3(s) + H_2SO_4(aq) \longrightarrow HOH(l) + CO_2(g) + CaSO_4(s)$$

5. potassium sulfite is reacted with hydrobromic acid

$$K_2SO_3(aq) + 2HBr(aq) \longrightarrow HOH(l) + SO_2(g) + 2KBr(aq)$$

6. potassium sulfide is reacted with nitric acid

$$K_2S(aq) + 2HNO_3(aq) \longrightarrow 2KNO_3(aq) + H_2S(g)$$

7. ammonium iodide + magnesium sulfate

$$2NH_4I(aq) + MgSO_4(aq) \rightleftharpoons MgI_2(aq) + (NH_4)_2SO_4(aq)$$

8. solid titanium(IV) carbonate + hydrochloric acid

$$Ti(CO_3)_2(s) + 4HCl(aq) \longrightarrow 2HOH(l) + 2CO_2(g) + TiCl_4(aq)$$

$$TiCl_4(aq) + 2HOH(l) \longrightarrow 4HCl(aq) + TiO_2(s)$$

9. solid calcium sulfite + acetic acid

$$CaSO_3(s) + 2CH_3COOH(aq) \longrightarrow Ca(CH_3COO)_2(aq) + HOH(l) + SO_2(g)$$

10. strontium hydroxide + ammonium sulfide

$$Sr(OH)_2(aq) + (NH_4)_2S(aq) \longrightarrow SrS(aq) + 2NH_3(g) + 2HOH(l)$$

ROUND 6

Exercise 9–3: Predict and balance the following reactions. Use the abbreviations (s), (l), (g), and (aq) for the reactants and products. All reactants are aqueous unless otherwise stated.

1. carbon dioxide gas is bubbled through a solution of lithium hydroxide

$$CO_2(g) + 2LiOH(aq) \longrightarrow Li_2CO_3(aq) + HOH(l)$$

or $$H_2CO_3(aq) + 2LiOH(aq) \longrightarrow Li_2CO_3(aq) + 2HOH(l)$$

2. sodium nitrite is reacted with hydrochloric acid

$$NaNO_2(aq) + HCl(aq) \longrightarrow HNO_2(aq) + NaCl(aq)$$

3. ammonium bromide + sodium hydroxide

$$NH_4Br(aq) + NaOH(aq) \longrightarrow NaBr(aq) + NH_3(g) + HOH(l)$$

4. carbon dioxide gas is reacted with solid potassium oxide

$$CO_2(g) + K_2O(s) \longrightarrow K_2CO_3(s)$$

5. solid magnesium oxide is reacted with hydrochloric acid

$$MgO(s) + 2HCl(aq) \longrightarrow MgCl_2(aq) + H_2O(l)$$

6. equal numbers of moles of potassium hydroxide and phosphoric acid react

$$KOH(aq) + H_3PO_4(aq) \longrightarrow HOH(l) + KH_2PO_4(aq)$$

7. sodium fluoride reacts with dilute nitric acid

$$NaF(aq) + HNO_3(aq) \longrightarrow HF(aq) + NaNO_3(aq)$$

8. ammonium carbonate + potassium bromide

$$(NH_4)_2CO_3(aq) + 2KBr(aq) \rightleftharpoons 2NH_4Br(aq) + K_2CO_3(aq)$$

9. oxalic acid (0.1 M) reacts with an equal volume of cesium hydroxide (0.1 M)

$$H_2C_2O_4(aq) + CsOH(aq) \longrightarrow CsHC_2O_4(aq) + HOH(l)$$

10. silver nitrate + sodium chromate

$$2AgNO_3(aq) + Na_2CrO_4(aq) \longrightarrow Ag_2CrO_4(s) + 2NaNO_3(aq)$$