Chemical Reaction Types KEY Name_____
Period_____

Identify each chemical reaction as a synthesis (combination), decomposition, single-replacement, double-replacement, or combustion reaction.

1. $2SO_2 + O_2 \rightarrow 2SO_3$ synthesis
2. $Al_2(SO_4)_3 + 3Ca(OH)_2 \rightarrow 2Al(OH)_3 + 3CaSO_4$ _____
3. $2C_2H_2 + 5O_2 \rightarrow 4CO_2 + 2H_2O$ _____
4. $Mg + 2AgNO_3 \rightarrow Mg(NO_3)_2 + 2Ag$ _____
5. $3Ba(NO_3)_2 + 2H_3PO_4 \rightarrow Ba_3(PO_4)_2 + 6HNO_3$ _____
6. $Mg(ClO_3)_2 \rightarrow MgCl_2 + 3O_2$ _____
7. $2Be + O_2 \rightarrow 2BeO$ _____
8. $2Al + 3CuSO_4 \rightarrow Al_2(SO_4)_3 + 3Cu$ _____
9. $2PbO_2 \rightarrow 2PbO + O_2$ _____
10. $2C_2H_6 + 7O_2 \rightarrow 4CO_2 + 6H_2O$ _____

Complete the chemical equations for the following SYNTHESIS (COMBINATION) reactions.

11. $Mg + O_2 \rightarrow$
12. $Ca + S \rightarrow$
13. $Na + O_2 \rightarrow$
14. $Na + Cl_2 \rightarrow$
15. $Al + O_2 \rightarrow$

Use the activity series of metals to complete the following SINGLE-REPLACEMENT reactions. Write "NR" if there is no reaction.

16. $Zn(s) + AgNO_3 \rightarrow$
17. $Au(s) + KNO_3 \rightarrow$
18. $Al(s) + H_2SO_4 \rightarrow$
19. $Cu(s) + H_2O \rightarrow$
20. $Al(s) + CuSO_4 \rightarrow$

Write the chemical equation for the complete COMBUSTION of the following compounds.

21. octane (C_8H_{18}) C_8H_{18} + _____ → _____ + _____

22. glucose ($C_6H_{12}O_6$) $C_6H_{12}O_6$ + _____ → _____ + _____

Complete the chemical equations for the following DOUBLE-REPLACEMENT reactions.

23. $Ag_2SO_4 + AlCl_3 \rightarrow$
24. $CdBr_2 + Na_2S \rightarrow$
25. $Pb(NO_3)_2 + NaI \rightarrow$
26. $NaOH + Fe(NO_3)_3 \rightarrow$
27. $NaNO_3 + BaCl_2 \rightarrow$

Write the type of reaction on the line. Then, predict the products of each reaction to complete the chemical equation. Write the correct formulas of the products after the arrow. Write "NR" if there is no reaction.

28. $Ag_2O \rightarrow$ _____
29. $C_4H_8 + O_2 \rightarrow$ _____
30. $Al + N_2 \rightarrow$ _____
31. $Zn + CuSO_4 \rightarrow$ _____
32. $Pb(NO_3)_2 + K_2CrO_4 \rightarrow$ _____
33. $Li + O_2 \rightarrow$ _____
34. $Al_2(SO_4)_3 + Ba(OH)_2 \rightarrow$ _____
35. $Cu + CaCO_3 \rightarrow$ _____
36. $C_3H_6 + O_2 \rightarrow$ _____
37. $Na_3PO_4 + Pb(NO_3)_2 \rightarrow$ _____

Write the chemical equation for the following reactions. Remember the diatomics. Use appropriate state symbols .

38. Solid silver carbonate decomposes into solid silver oxide and gaseous carbon dioxide when heated.

39. Adding chlorine gas to a solution of potassium iodide gives solid iodine and a solution of potassium chloride.

40. Iodine crystals react with chlorine gas to form solid iodine trichloride.

Chemical Reaction Types

Name_____
Period_____

Identify each chemical reaction as a synthesis (combination), decomposition, single-replacement, double-replacement, or combustion reaction.

1. $2SO_2 + O_2 \rightarrow 2SO_3$ — Synthesis
2. $Al_2(SO_4)_3 + 3Ca(OH)_2 \rightarrow 2Al(OH)_3 + 3CaSO_4$ — Double
3. $2C_2H_2 + 5O_2 \rightarrow 4CO_2 + 2H_2O$ — combustion
4. $Mg + 2AgNO_3 \rightarrow Mg(NO_3)_2 + 2Ag$ — Single
5. $3Ba(NO_3)_2 + 2H_3PO_4 \rightarrow Ba_3(PO_4)_2 + 6HNO_3$ — Double
6. $Mg(ClO_3)_2 \rightarrow MgCl_2 + 3O_2$ — Decomposition
7. $2Be + O_2 \rightarrow 2BeO$ — Synthesis
8. $2Al + 3CuSO_4 \rightarrow Al_2(SO_4)_3 + 3Cu$ — Single
9. $2PbO_2 \rightarrow 2PbO + O_2$ — Decomposition
10. $2C_2H_6 + 7O_2 \rightarrow 4CO_2 + 6H_2O$ — combustion

Complete the chemical equations for the following SYNTHESIS (COMBINATION) reactions.

11. $2Mg + O_2 \rightarrow 2MgO$
12. $Ca + S \rightarrow CaS$
13. $2Na + O_2 \rightarrow Na_2O$
14. $2Na + Cl_2 \rightarrow 2NaCl$
15. $4Al + 3O_2 \rightarrow 2Al_2O_3$

Use the activity series of metals to complete the following SINGLE-REPLACEMENT reactions. Write "NR" if there is no reaction.

16. $Zn(s) + AgNO_3 \rightarrow ZnNO_3 + Ag$
17. $Au(s) + KNO_3 \rightarrow$ no rxn
18. $2Al(s) + 3H_2SO_4 \rightarrow Al_2(SO_4)_3 + 3H_2$
19. $Cu(s) + H_2O \rightarrow$
20. $2Al(s) + 3CuSO_4 \rightarrow$ No Rx

$Al_2(SO_4)_3 + 3Cu$

Write the chemical equation for the complete COMBUSTION of the following compounds.

21. octane (C_8H_{18}) $C_8H_{18} + \frac{27}{2}O_2 \rightarrow 8CO_2 + 9H_2O$
22. glucose ($C_6H_{12}O_6$) $C_6H_{12}O_6 + 9O_2 \rightarrow 6CO_2 + 6H_2O$

Chemistry I

Complete the chemical equations for the following DOUBLE-REPLACEMENT reactions.

23. $3\ Ag_2SO_4 + 2\ AlCl_3 \rightarrow 6\ AgCl + Al_2(SO_4)_3$
24. $CdBr_2 + Na_2S \rightarrow CdS + 2\ NaBr$
25. $Pb(NO_3)_2 + 2\ NaI \rightarrow PbI_2 + 2\ NaNO_3$
26. $3\ NaOH + Fe(NO_3)_3 \rightarrow Fe(OH)_3 + 3\ NaNO_3$
27. $2\ NaNO_3 + BaCl_2 \rightarrow Ba(NO_3)_2 + 2\ NaCl$

Write the type of reaction on the line. Then, predict the products of each reaction to complete the chemical equation. Write the correct formulas of the products after the arrow. Write "NR" if there is no reaction.

28. $Ag_2O \rightarrow$ _____
29. $C_4H_8 + O_2 \rightarrow$ _____
30. $Al + N_2 \rightarrow$ _____
31. $Zn + CuSO_4 \rightarrow$ _____
32. $Pb(NO_3)_2 + K_2CrO_4 \rightarrow$ _____
33. $Li + O_2 \rightarrow$ _____
34. $Al_2(SO_4)_3 + Ba(OH)_2 \rightarrow$ _____
35. $Cu + CaCO_3 \rightarrow$ _____
36. $C_3H_6 + O_2 \rightarrow$ _____
37. $Na_3PO_4 + Pb(NO_3)_2 \rightarrow$ _____

Write the chemical equation for the following reactions. Remember the diatomics. Use appropriate state symbols .

38. Solid silver carbonate decomposes into solid silver oxide and gaseous carbon dioxide when heated.

39. Adding chlorine gas to a solution of potassium iodide gives solid iodine and a solution of potassium chloride.

40. Iodine crystals react with chlorine gas to form solid iodine trichloride.

Name: _____ Date: _____ Period: 1 2 3 4 5 6 7

Types of Chemical Reaction Worksheet

*Balance the reactions **1 to 6** and indicate which type of chemical reaction (synthesis, decomposition, single-displacement, double-displacement or combustion) is being represented:*

1. ____ $NaBr$ + ____ $Ca(OH)_2$ → ___ $CaBr_2$ + ____ $NaOH$ Reaction Type : _____

2. ____ NH_3+ ____ H_2SO_4 → ____ $(NH_4)_2SO_4$ Reaction Type : _____

3. ____ C_5H_9O + ____ O_2 → ____ CO_2 + ____ H_2O Reaction Type : _____

4. ____ Pb + ____ H_3PO_4 → ____ H_2 + ____ $Pb_3(PO_4)_2$ Reaction Type : _____

5. ____ Li_3N + ____ NH_4NO_3 → ___ $LiNO_3$ + ___ $(NH_4)_3N$ Reaction Type : _____

6. ____ HBr + ___ $Al(OH)_3$ → ___ H_2O + ___ $AlBr_3$ Reaction Type : _____

Indicate which type of chemical reaction (synthesis, decomposition, single-displacement, double-displacement or combustion) is being represented in 7 to 20.

7. $Na_3PO_4 + 3\ KOH \rightarrow 3\ NaOH + K_3PO_4$ Reaction Type _____

8. $MgCl_2 + Li_2CO_3 \rightarrow MgCO_3 + 2\ LiCl$ Reaction Type _____

9. $C_6H_{12} + 9\ O_2 \rightarrow 6\ CO_2 + 6\ H_2O$ Reaction Type _____

10. $Pb + FeSO_4 \rightarrow PbSO_4 + Fe$ Reaction Type _____

11. $CaCO_3 \rightarrow CaO + CO_2$ Reaction Type _____

12. $P_4 + 3\ O_2 \rightarrow 2\ P_2O_3$ Reaction Type _____

13. $2\ RbNO_3 + BeF_2 \rightarrow Be(NO_3)_2 + 2\ RbF$ Reaction Type _____

14. $2\ AgNO_3 + Cu \rightarrow Cu(NO_3)_2 + 2\ Ag$ Reaction Type _____

15. $C_3H_6O + 4\ O_2 \rightarrow 3\ CO_2 + 3\ H_2O$ Reaction Type _____

16. $2\ C_5H_5 + Fe \rightarrow Fe(C_5H_5)_2$ Reaction Type _____

17. $SeCl_6 + O_2 \rightarrow SeO_2 + 3Cl_2$ Reaction Type _____

18. $2\ MgI_2 + Mn(SO_3)_2 \rightarrow 2\ MgSO_3 + MnI_4$ Reaction Type _____

19. $O_3 \rightarrow O + O_2$ Reaction Type _____

20. $2\ NO_2 \rightarrow 2\ O_2 + N_2$ Reaction Type _____

Name: KEY Date: _____ Period: 1 2 3 4 5 6 7

Types of Chemical Reaction Worksheet

*Balance the reactions **1 to 6** and indicate which type of chemical reaction (synthesis, decomposition, single-displacement, double-displacement or combustion) is being represented:*

1. 2 NaBr + ____ $Ca(OH)_2$ → ___ $CaBr_2$ + 2 NaOH Reaction Type : Double

2. 2 NH_3 + ____ H_2SO_4 → ____ $(NH_4)_2SO_4$ Reaction Type : synthesis

$2C_2H_2 + 5O_2 \rightarrow 2CO_2 + H_2O$

3. ____ C_5H_9O + ____ O_2 → ____ CO_2 + ____ H_2O Reaction Type : combustion

4. 3 Pb + 2 H_3PO_4 → 3 H_2 + ____ $Pb_3(PO_4)_2$ Reaction Type : single replacement

5. ____ Li_3N + 3 NH_4NO_3 → 3 $LiNO_3$ + ___ $(NH_4)_3N$ Reaction Type : Double

6. 3 HBr + ___ $Al(OH)_3$ → 3 H_2O + ___ $AlBr_3$ Reaction Type : Double

Indicate which type of chemical reaction (synthesis, decomposition, single-displacement, double-displacement or combustion) is being represented in 7 to 20.

7. Na_3PO_4 + 3 KOH → 3 NaOH + K_3PO_4 Reaction Type Double

8. $MgCl_2$ + Li_2CO_3 → $MgCO_3$ + 2 LiCl Reaction Type Double

9. C_6H_{12} + 9 O_2 → 6 CO_2 + 6 H_2O Reaction Type combustion

10. Pb + $FeSO_4$ → $PbSO_4$ + Fe Reaction Type single

11. $CaCO_3$ → CaO + CO_2 Reaction Type Decomposition

12. P_4 + 3 O_2 → 2 P_2O_3 Reaction Type synthesis

13. 2 $RbNO_3$ + BeF_2 → $Be(NO_3)_2$ + 2 RbF Reaction Type Double

14. 2 $AgNO_3$ + Cu → $Cu(NO_3)_2$ + 2 Ag Reaction Type single

15. C_3H_6O + 4 O_2 → 3 CO_2 + 3 H_2O Reaction Type combustion

16. 2 C_5H_5 + Fe → $Fe(C_5H_5)_2$ Reaction Type synthesis

17. $SeCl_6$ + O_2 → SeO_2 + 3Cl_2 Reaction Type single

18. 2 MgI_2 + $Mn(SO_3)_2$ → 2 $MgSO_3$ + MnI_4 Reaction Type Double

19. O_3 → O + O_2 Reaction Type Decomposition

20. 2 NO_2 → 2 O_2 + N_2 Reaction Type Decomposition

Name _____ Date _____ Period 1 2 3 4 5 6 7

Types of Chemical Reaction Worksheet

*Balance the reactions **1 to 6** and indicate which type of chemical reaction (synthesis, decomposition, single-displacement, double-displacement or combustion) is being represented:*

1. 2 NaBr + ____ $Ca(OH)_2$ → ___ $CaBr_2$ + 2 NaOH Reaction Type: Double
2. 2 NH_3 + ____ H_2SO_4 → ____ $(NH_4)_2SO_4$ Reaction Type: Synthesis
3. ____ C_5H_9O + ____ O_2 → ____ CO_2 + ____ H_2O Reaction Type: combustion
4. 3 Pb + 2 H_3PO_4 → 3 H_2 + ____ $Pb_3(PO_4)_2$ Reaction Type: single
5. ____ Li_3N + 3 NH_4NO_3 → 3 $LiNO_3$ + ___ $(NH_4)_3N$ Reaction Type: Double
6. 3 HBr + ___ $Al(OH)_3$ → 3 H_2O + ___ $AlBr_3$ Reaction Type: Double

Indicate which type of chemical reaction (synthesis, decomposition, single-displacement, double-displacement or combustion) is being represented in 7 to 20.

7. Na_3PO_4 + 3 KOH → 3 NaOH + K_3PO_4 Reaction Type: Double
8. $MgCl_2$ + Li_2CO_3 → $MgCO_3$ + 2 LiCl Reaction Type: Double
9. C_6H_{12} + 9 O_2 → 6 CO_2 + 6 H_2O Reaction Type: combustion
10. Pb + $FeSO_4$ → $PbSO_4$ + Fe Reaction Type: single
11. $CaCO_3$ → CaO + CO_2 Reaction Type: Decomposition
12. P_4 + 3 O_2 → 2 P_2O_3 Reaction Type: synthesis
13. 2 $RbNO_3$ + BeF_2 → $Be(NO_3)_2$ + 2 RbF Reaction Type: Double
14. 2 $AgNO_3$ + Cu → $Cu(NO_3)_2$ + 2 Ag Reaction Type: single
15. C_3H_6O + 4 O_2 → 3 CO_2 + 3 H_2O Reaction Type: combustion
16. 2 C_5H_5 + Fe → $Fe(C_5H_5)_2$ Reaction Type: synthesis
17. $SeCl_6$ + O_2 → SeO_2 + 3Cl_2 Reaction Type: single
18. 2 MgI_2 + $Mn(SO_3)_2$ → 2 $MgSO_3$ + MnI_4 Reaction Type: Double
19. O_3 → O + O_2 Reaction Type: Decomposition
20. 2 NO_2 → 2 O_2 + N_2 Reaction Type: Decomposition

Name _____ Date _____ Class _____

11.3 REACTIONS IN AQUEOUS SOLUTION

Section Review

Objectives

- Describe the information found in a net ionic equation
- Predict the formation of a precipitate in a double-replacement reaction

Vocabulary

- complete ionic equation
- spectator ion
- net ionic equation

Part A Completion

Use this completion exercise to check your understanding of the concepts and terms that are introduced in this section. Each blank can be completed with a term, short phrase, or number.

Many important chemical reactions take place in __1__, which makes up 66 percent of the human body. Reactions in water are said to take place in __2__ solution.

A double-replacement reaction can be written as a __3__, which shows dissolved ionic compounds as their free ions. Ions that appear on both sides of the equation and are not directly involved in the reaction are called __4__. Canceling these ions from the equation leaves the __5__, which indicates only those particles that take part in the reaction.

When balancing a net ionic equation, it is necessary to balance the electric __6__ as well as the number of __7__.

When mixing solutions of ions, it is possible to predict the formation of a __8__. This prediction can be made using the general rules for __9__ of ionic compounds.

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____

Name _____ Date _____ Class _____

Part B True-False

Classify each of these statements as always true, AT; sometimes true, ST; or never true, NT.

_____ **10.** A precipitate is formed when two ionic solutions are mixed.

_____ **11.** Spectator ions are not part of a net ionic equation.

_____ **12.** Balancing the atoms in a net ionic equation will cause the charges to balance.

_____ **13.** A net ionic equation shows all ions present.

Part C Matching

Match each description in Column B to the correct term in Column A.

Column A	Column B
_____ **14.** complete ionic equation	**a.** equation that indicates only the particles that take part in a reaction
_____ **15.** spectator ions	**b.** solid product of reaction in solution
_____ **16.** net ionic equation	**c.** reaction that occurs in water
_____ **17.** precipitate	**d.** equation that shows dissolved ionic compounds as free ions
_____ **18.** aqueous reaction	**e.** used to predict whether a precipitate will form in an aqueous reaction
_____ **19.** ionic solubility rules	**f.** ions that do not participate in a reaction

Part D Questions and Problems

Answer the following in the space provided.

20. Identify the spectator ion(s) and write a balanced net ionic equation for this reaction.

$Cl_2(g) + NaBr(aq) \rightarrow Br_2(l) + NaCl(aq)$

21. Predict which precipitate, if any, will form in the following reactions:

a. $AgNO_3(aq) + NaCl(aq) \rightarrow$

b. $CaCl_2(aq) + Na_2CO_3(aq) \rightarrow$

c. $Fe(NO_3)_3(aq) + KCl(aq) \rightarrow$

d. $Pb(NO_3)_2(aq) + HCl(aq) \rightarrow$

Name _____ Date _____ Class _____

11.3 REACTIONS IN AQUEOUS SOLUTION

Section Review

Objectives

- Describe the information found in a net ionic equation
- Predict the formation of a precipitate in a double-replacement reaction

Vocabulary

- complete ionic equation
- spectator ion
- net ionic equation

Part A Completion

Use this completion exercise to check your understanding of the concepts and terms that are introduced in this section. Each blank can be completed with a term, short phrase, or number.

Many important chemical reactions take place in __1__, which makes up 66 percent of the human body. Reactions in water are said to take place in __2__ solution.

A double-replacement reaction can be written as a __3__, which shows dissolved ionic compounds as their free ions. Ions that appear on both sides of the equation and are not directly involved in the reaction are called __4__. Canceling these ions from the equation leaves the __5__, which indicates only those particles that take part in the reaction.

When balancing a net ionic equation, it is necessary to balance the electric __6__ as well as the number of __7__.

When mixing solutions of ions, it is possible to predict the formation of a __8__. This prediction can be made using the general rules for __9__ of ionic compounds.

1. water
2. aqueous
3. complete
4. spectator
5. net ionic
6. charge
7. atoms
8. precipitate
9. solubility

Name _____ Date _____ Class _____

11.2 TYPES OF CHEMICAL REACTIONS

Section Review

Objectives

- Describe the five general types of reactions
- Predict the products of the five general types of reactions

Vocabulary

- combination reaction
- decomposition reaction
- single-replacement reaction
- activity series
- double-replacement reaction
- combustion reaction

Part A Completion

Use this completion exercise to check your understanding of the concepts and terms that are introduced in this section. Each blank can be completed with a term, short phrase, or number.

It is possible to __1__ the products of some chemical reactions. In order to do this, you must be able to recognize at least five general types of reactions. For example, in a __2__ reaction, the reactants are two or more __3__ and/or compounds and there is always a __4__ product. In a __5__ reaction, a single compound is broken down into two or more simpler substances.

In a __6__ reaction, the reactants and products are an element and a compound. The __7__ can be used to predict whether most single-replacement reactions will take place.

A __8__ reaction involves the exchange of ions between two compounds. This reaction generally takes place between two ionic compounds in __9__ solution. One of the reactants in a combustion reaction is __10__. The products of the complete combustion of a hydrocarbon are __11__ and __12__.

1. _____
2. _____
3. _____
4. _____
5. _____
6. _____
7. _____
8. _____
9. _____
10. _____
11. _____
12. _____

Name _____ Date _____ Class _____

11.2 TYPES OF CHEMICAL REACTIONS

Section Review

Objectives

- Describe the five general types of reactions
- Predict the products of the five general types of reactions

Vocabulary

- combination reaction
- decomposition reaction
- single-replacement reaction
- activity series
- double-replacement reaction
- combustion reaction

Part A Completion

Use this completion exercise to check your understanding of the concepts and terms that are introduced in this section. Each blank can be completed with a term, short phrase, or number.

It is possible to __1__ the products of some chemical reactions. In order to do this, you must be able to recognize at least five general types of reactions. For example, in a __2__ reaction, the reactants are two or more __3__ and/or compounds and there is always a __4__ product. In a __5__ reaction, a single compound is broken down into two or more simpler substances.

In a __6__ reaction, the reactants and products are an element and a compound. The __7__ can be used to predict whether most single-replacement reactions will take place.

A __8__ reaction involves the exchange of ions between two compounds. This reaction generally takes place between two ionic compounds in __9__ solution. One of the reactants in a combustion reaction is __10__. The products of the complete combustion of a hydrocarbon are __11__ and __12__.

1. predict
2. Synthesis
3. Elements
4. Single
5. Decomposition
6. Single Replace
7. Activity ser.
8. Double
9. aqueous
10. O_2
11. H_2O
12. CO_2

Name _____ Date _____ Class _____

Part B True-False

Classify each of these statements as always true, AT; sometimes true, ST; or never true, NT.

AT 13. In a decomposition reaction, there is a single reactant.

NT 14. The activity series of metals can be used to predict products in double-replacement reactions.

AT 15. Carbon dioxide and water are the products of the combustion of hexane (C_6H_{14}).

ST 16. A nonmetal can replace another nonmetal from a compound in a single-replacement reaction.

ST 17. One of the products of a double-replacement reaction is a gas that bubbles out of the mixture.

Part C Matching

Match each description in Column B to the correct term in Column A.

Column A	Column B
B 18. combination reaction	a. reaction in which atoms of one element replace atoms of a second element in a compound
D 19. decomposition reaction	b. a reaction in which two or more substances combine to form a single substance
A 20. single-replacement reaction	c. reaction of a compound with oxygen to produce energy
C 21. combustion reaction	d. reaction in which a single compound is broken down into two or more products

Part D Questions and Problems

Answer the following in the space provided.

22. Identify the type of each of the following reactions.

a. $2C_6H_{14}(l) + 19O_2(g) \rightarrow 12CO_2(g) + 14H_2O(g)$ combustion

b. $2Fe(s) + 3Br_2(l) \rightarrow 2FeBr_3(s)$ synthesis

23. Complete and balance the following equation. What must be true of one of the products?

$Li_3PO_4 + Zn(NO_3)_2 \rightarrow$

$2Li_3PO_4 + 3Zn(NO_3)_2 \rightarrow Zn_3(PO_4)_2(s) + 6LiNO_3$

one of the products is a solid.

PRACTICE PROBLEMS ON NET IONIC EQUATIONS

Show the total ionic and net ionic forms of the following equations. If all species are spectator ions, please indicate that no reaction takes place. Note! You need to make sure the original equation is balanced before proceeding! A set of solubility rules are given at the end of this document.

1. $AgNO_3(aq) + KCl(aq) \rightarrow AgCl(s) + KNO_3(aq)$

2. $Mg(NO_3)_2(aq) + Na_2CO_3(aq) \rightarrow MgCO_3(s) + NaNO_3(aq)$

3. strontium bromide(aq) + potassium sulfate(aq) → strontium sulfate(s) + potassium bromide(aq)

4. manganese(II)chloride(aq) + ammonium carbonate(aq) → manganese(II)carbonate(s) + ammonium chloride(aq)

5. chromium(III)nitrate(aq) + iron(II)sulfate(aq) → chromium(III)sulfate(aq) + iron(II)nitrate(aq)

Please complete the following reactions, and show the total ionic and net ionic forms of the equation:

6. $K_3PO_4(aq) + Al(NO_3)_3(aq) \rightarrow$

7. $BeI_2(aq) + Cu_2SO_4(aq) \rightarrow$

8. $Ni(NO_3)_3(aq) + KBr(aq) \rightarrow$

9. cobalt(III)bromide + potassium sulfide →

10. barium nitrate + ammonium phosphate →

11. calcium hydroxide + iron(III)chloride →

12. rubidium fluoride + copper(II)sulfate →

Solubility Rules

1. All salts of Group IA, and ammonium are soluble.
2. All salts of nitrates, chlorates and acetates are soluble.
3. All salts of halides are soluble except those of silver(I), copper(I), lead(II), and mercury(I).
4. All salts of sulfate are soluble except for barium sulfate, lead(II) sulfate, and strontium sulfate.
5. All salts of carbonate, phosphate and sulfite are insoluble, except for those of group IA and ammonium.
6. All oxides and hydroxides are insoluble except for those of group IA, calcium, strontium and barium.
7. All salts of sulfides and insoluble except for those of Group IA and IIA elements and of ammonium.

1) $AgNO_{3(aq)} + KCl_{(aq)} \rightarrow AgCl_{(s)} + KNO_3$

$Ag^+ + NO_3^- + K^+ + Cl^- \rightarrow AgCl_{(s)} + K^+ + NO_3^-$

$Ag^+ + Cl^- \rightarrow AgCl_{(s)}$

2) $Mg(NO_3)_2 + Na_2CO_3 \rightarrow MgCO_{3(s)} + 2NaNO_3$

$Mg^{2+} + 2NO_3^- + 2Na^+ + CO_3^{2-} \rightarrow$

$MgCO_{3(s)} + 2Na^+ + 2NO_3^-$

$Mg^{2+} + CO_3^{2-} \rightarrow MgCO_{3(s)}$

3) $SrBr_2 + K_2SO_4 \rightarrow SrSO_{4(s)} + 2KBr$

$Sr^{2+} + 2Br^- + 2K^+ + SO_4^{2-} \rightarrow$

$SrSO_{4(s)} + 2K^+ + 2Br^-$

$Sr^{2+} + SO_4^{2-} \rightarrow SrSO_{4(s)}$

4) $MnCl_2 + (NH_4)_2CO_3 \rightarrow MnCO_{3(s)} + 2NH_4Cl$

$Mn^{2+} + 2Cl^- + 2NH_4^+ + CO_3^{2-} \rightarrow$

$MnCO_{3(s)} + 2NH_4^+ + 2Cl^-$

$Mn^{2+} + CO_3^{2-} \rightarrow MnCO_{3(s)}$

5) $Cr(NO_3)_3 + FeSO_4 \rightarrow$ NR

6) $K_3PO_4 + Al(NO_3)_3 \rightarrow AlPO_{4(s)} + 3KNO_3$

$3K^+ + PO_4^{3-} + Al^{3+} + 3NO_3^- \rightarrow$

$AlPO_{4(s)} + 3K^+ + 3NO_3^-$

$Al^{3+} + PO_4^{3-} \rightarrow AlPO_{4(s)}$

9) $2CoBr_3 + 3K_2S \rightarrow Co_2S_{3(s)} + 6KBr$

$2Co^{3+} + 6Br^- + 6K^+ + 3S^{2-} \longrightarrow$

$Co_2S_{3(s)} + 6K^+ + 6Br^-$

$2Co^{3+} + 3S^{2-} \rightarrow Co_2S_{3(s)}$

10) $3Ba(NO_3)_2 + 2(NH_4)_3PO_4 \longrightarrow$

$Ba_3(PO_4)_{2(s)} + 6NH_4NO_3$

$3Ba^{2+} + 6NO_3^- + 6NH_4^+ + 2PO_4^{3-} \rightarrow$

$Ba_3(PO_4)_{2(s)} + 6NO_3^- + 6NH_4^+$

$3Ba^{2+} + 2PO_4^{3-} \rightarrow Ba_3(PO_4)_{2(s)}$

9) $2CoBr_3 + 3K_2S \rightarrow Co_2S_{3(s)} + 6KBr$

$2Co^{3+} + 6Br^- + 6K^+ + 3S^{2-} \rightarrow$

$Co_2S_{3(s)} + 6K^+ + 6Br^-$

$2Co^{3+} + 3S^{2-} \rightarrow Co_2S_{3(s)}$

10) $3Ba(NO_3)_2 + 2(NH_4)_3PO_4 \rightarrow$

$Ba_3(PO_4)_{2(s)} + 6NH_4NO_3$

$3Ba^{2+} + 6NO_3^- + 6NH_4^+ + 2PO_4^{3-} \rightarrow$

$Ba_3(PO_4)_{2(s)} + 6NO_3^- + 6NH_4^+$

$3Ba^{2+} + 2PO_4^{3-} \rightarrow Ba_3(PO_4)_{2(s)}$

11)

$$3Ca(OH)_2 + 2FeCl_3 \rightarrow 2Fe(OH)_{3(s)} + 3CaCl_2$$

$$3Ca^{2+} + 6OH^- + 2Fe^{3+} + 6Cl^- \rightarrow 2Fe(OH)_{3(s)} + 3Ca^{2+} + 6Cl^-$$

$$2Fe^{3+} + 6OH^- \rightarrow 2Fe(OH)_{3(s)}$$

Table 3.3 Solubility characteristics of ionic compounds in water at 25°C

1. All alkali metal (Group 1A) compounds are soluble.
2. All ammonium (NH_4^+) compounds are soluble.
3. All compounds containing nitrate (NO_3^-), chlorate (ClO_3^-), and perchlorate (ClO_4^-) are soluble.
4. Most hydroxides (OH^-) are insoluble. The exceptions are the alkali metal hydroxides and barium hydroxide [$Ba(OH)_2$]. Calcium hydroxide [$Ca(OH)_2$] is slightly soluble.
5. Most compounds containing chlorides (Cl^-), bromides (Br^-), or iodides (I^-) are soluble. The exceptions are those containing Ag^+, Hg_2^{2+}, and Pb^{2+}.
6. All carbonates (CO_3^{2-}), phosphates (PO_4^{3-}), and sulfides (S^{2-}) are insoluble; the exceptions are those of alkali metals and the ammonium ion.
7. Most sulfates (SO_4^{2-}) are soluble. Calcium sulfate ($CaSO_4$) and silver sulfate (Ag_2SO_4) are slightly soluble. Barium sulfate ($BaSO_4$), mercury(II) sulfate ($HgSO_4$), and lead sulfate ($PbSO_4$) are insoluble.

Identify each of the following substances as a strong electrolyte, a weak electrolyte, or a nonelectrolyte: (a) H_2O, (b) KCl, (c) HNO_3, (d) CH_3COOH, (e) $C_{12}H_{22}O_{11}$, (f) $Ba(NO_3)_2$, (g) Ne, (h) NH_3, (i) NaOH.

Characterize the following compounds as soluble or insoluble in water: (a) $Ca_3(PO_4)_2$, (b) $Mn(OH)_2$, (c) $AgClO_3$, (d) K_2S, (e) $CaCO_3$, (f) $ZnSO_4$, (g) $Hg(NO_3)_2$, (h) $HgSO_4$, (i) NH_4ClO_4.

Predict the result of each of the following reactions.

a. ~~$HF(aq) + Hg_2(NO_3)_2(aq) \rightarrow$~~

b. $LiI(aq) + AgNO_3(aq) \rightarrow$

c. $K_2S(aq) + Co(CH_3COO)_2(aq) \rightarrow$

d. $NaOH(aq) + Cr_2(SO_4)_3(aq) \rightarrow$

work sheet #1

1) A non/very weak H_2O
B KCl strong
C HNO_3 strong
D CH_3COH weak
E Sugar non
F $Ba(NO_3)_2$ strong
G NE non
H NH_3 weak
I NaOH strong

2 A $Ca_3(PO_4)_2$ Insol.
B $Mn(OH)_2$ Insol.
C $AgClO_3$ sol.
D K_2S sol.
E $CaCO_3$ Insol.
F $ZnSO_4$ sol
G $Hg(NO_3)_2$ sol.
H Hg_2SO_4 Insol
I NH_4ClO_4 sol

3a $2HF_{(aq)} + Hg_2(NO_3)_{2(aq)} \longrightarrow Hg_2F_{2(s)} + 2HNO_{3(aq)}$

$LiI_{(aq)} + AgNO_{3(aq)} \longrightarrow AgI_{(s)} + LiNO_{3(aq)}$

$K_2S_{(aq)} + Co(CH_3COO)_{2(aq)} \longrightarrow CoS_{(s)} + 2kCH_3COO_{(aq}$

$6NaOH_{(aq)} + Cr_2(SO_4)_{3(aq)} \longrightarrow 3Na_2SO_{4(aq)} + 2Cr(OH)_{3(s)}$

Name _____ Date _____ Class _____

Part B True-False

Classify each of these statements as always true, AT; sometimes true, ST; or never true, NT.

_____ **13.** In a decomposition reaction, there is a single reactant.

_____ **14.** The activity series of metals can be used to predict products in double-replacement reactions.

_____ **15.** Carbon dioxide and water are the products of the combustion of hexane (C_6H_{14}).

_____ **16.** A nonmetal can replace another nonmetal from a compound in a single-replacement reaction.

_____ **17.** One of the products of a double-replacement reaction is a gas that bubbles out of the mixture.

Part C Matching

Match each description in Column B to the correct term in Column A.

Column A	Column B
_____ **18.** combination reaction	**a.** reaction in which atoms of one element replace atoms of a second element in a compound
_____ **19.** decomposition reaction	**b.** a reaction in which two or more substances combine to form a single substance
_____ **20.** single-replacement reaction	**c.** reaction of a compound with oxygen to produce energy
_____ **21.** combustion reaction	**d.** reaction in which a single compound is broken down into two or more products

Part D Questions and Problems

Answer the following in the space provided.

22. Identify the type of each of the following reactions.

a. $2C_6H_{14}(l) + 19O_2(g) \rightarrow 12CO_2(g) + 14H_2O(g)$

_____

b. $2Fe(s) + 3Br_2(l) \rightarrow 2FeBr_3(s)$

_____

23. Complete and balance the following equation. What must be true of one of the products?

$Li_3PO_4 + Zn(NO_3)_2 \rightarrow$

_____

_____

Part B True-False

Classify each of these statements as always true, AT; sometimes true, ST; or never true, NT.

_____ **10.** A precipitate is formed when two ionic solutions are mixed.

_____ **11.** Spectator ions are not part of a net ionic equation.

_____ **12.** Balancing the atoms in a net ionic equation will cause the charges to balance.

_____ **13.** A net ionic equation shows all ions present.

Part C Matching

Match each description in Column B to the correct term in Column A.

Column A	Column B
_____ **14.** complete ionic equation	**a.** equation that indicates only the particles that take part in a reaction
_____ **15.** spectator ions	**b.** solid product of reaction in solution
_____ **16.** net ionic equation	**c.** reaction that occurs in water
_____ **17.** precipitate	**d.** equation that shows dissolved ionic compounds as free ions
_____ **18.** aqueous reaction	**e.** used to predict whether a precipitate will form in an aqueous reaction
_____ **19.** ionic solubility rules	**f.** ions that do not participate in a reaction

Part D Questions and Problems

Answer the following in the space provided.

20. Identify the spectator ion(s) and write a balanced net ionic equation for this reaction.

$Cl_2(g) + NaBr(aq) \rightarrow Br_2(l) + NaCl(aq)$

21. Predict which precipitate, if any, will form in the following reactions:

a. $AgNO_3(aq) + NaCl(aq) \rightarrow$

b. $CaCl_2(aq) + Na_2CO_3(aq) \rightarrow$

c. $Fe(NO_3)_3(aq) + KCl(aq) \rightarrow$

d. $Pb(NO_3)_2(aq) + HCl(aq) \rightarrow$

Name _____ Date _____ Class _____

Part B True-False

Classify each of these statements as always true, AT; sometimes true, ST; or never true, NT.

AT 13. In a decomposition reaction, there is a single reactant.

NT 14. The activity series of metals can be used to predict products in double-replacement reactions.

AT 15. Carbon dioxide and water are the products of the combustion of hexane (C_6H_{14}).

ST 16. A nonmetal can replace another nonmetal from a compound in a single-replacement reaction.

ST 17. One of the products of a double-replacement reaction is a gas that bubbles out of the mixture.

Part C Matching

Match each description in Column B to the correct term in Column A.

Column A	Column B
B 18. combination reaction	a. reaction in which atoms of one element replace atoms of a second element in a compound
D 19. decomposition reaction	b. a reaction in which two or more substances combine to form a single substance
A 20. single-replacement reaction	c. reaction of a compound with oxygen to produce energy
C 21. combustion reaction	d. reaction in which a single compound is broken down into two or more products

Part D Questions and Problems

Answer the following in the space provided.

22. Identify the type of each of the following reactions.

a. $2C_6H_{14}(l) + 19O_2(g) \rightarrow 12CO_2(g) + 14H_2O(g)$ combustion

b. $2Fe(s) + 3Br_2(l) \rightarrow 2FeBr_3(s)$ synthesis / combination

23. Complete and balance the following equation. What must be true of one of the products?

2 Li_3PO_4 + 3 $Zn(NO_3)_2$ → $Zn_3(PO_4)_2(s)$ + 6 $LiNO_3$

Name _____ Date _____ Class _____

Part B True-False

Classify each of these statements as always true, AT; sometimes true, ST; or never true, NT.

ST 10. A precipitate is formed when two ionic solutions are mixed.

AT 11. Spectator ions are not part of a net ionic equation.

AT 12. Balancing the atoms in a net ionic equation will cause the charges to balance.

NT 13. A net ionic equation shows all ions present.

Part C Matching

Match each description in Column B to the correct term in Column A.

Column A	Column B
D 14. complete ionic equation	a. equation that indicates only the particles that take part in a reaction
F 15. spectator ions	b. solid product of reaction in solution
A 16. net ionic equation	c. reaction that occurs in water
B 17. precipitate	d. equation that shows dissolved ionic compounds as free ions
C 18. aqueous reaction	e. used to predict whether a precipitate will form in an aqueous reaction
E 19. ionic solubility rules	f. ions that do not participate in a reaction

Part D Questions and Problems

Answer the following in the space provided.

20. Identify the spectator ion(s) and write a balanced net ionic equation for this reaction.

$Cl_2(g) + NaBr(aq) \rightarrow Br_2(l) + NaCl(aq)$

$Cl_2 + 2Na^+ + 2Br^- \Rightarrow Br_2 + 2Na^+ + 2Cl^-$

$Cl_2 + 2Br^- \rightarrow 2Cl^- + Br_2$

21. Predict which precipitate, if any, will form in the following reactions:

a. $AgNO_3(aq) + NaCl(aq) \rightarrow$ $AgCl_{(s)} + NaNO_3\ aq$

b. $CaCl_2(aq) + Na_2CO_3(aq) \rightarrow$ $CaCO_{3(s)} + 2NaCl\ (aq)$

c. $Fe(NO_3)_3(aq) + KCl(aq) \rightarrow$ NR

d. $Pb(NO_3)_2(aq) + HCl(aq) \rightarrow$ $PbCl_{2(s)} + 2HNO_3\ (aq)$

Net Ionic Equations
Advanced Chem Worksheet 10-4

KEY

Name _____

When two solutions of ionic compounds are mixed, a solid may form. This type of reaction is called a **precipitation reaction**, and the solid produced in the reaction is known as the **precipitate**. You can predict whether a precipitate will form using a list of solubility rules such as those found in the table below. When a combination of ions is described as insoluble, a precipitate forms.

There are three types of equations that are commonly written to describe a precipitation reaction. The **molecular equation** shows each of the substances in the reaction as compounds with physical states written next to the chemical formulas. The **complete ionic equation** shows each of the compounds as separate ions if they are water soluble. Insoluble substances are not separated and these have the symbol (*s*) written next to them.

Notice that there are ions that are present on both sides of the reaction arrow – that is, they do not react. These ions are known as **spectator ions** and they are commonly eliminated from complete ionic equation by crossing them out. The remaining equation is known as the **net ionic equation.**

Solubility Rules
Rule 1 supercedes rule 2, rule 2 supercedes rule 3, etc.

1. **Nitrate** (NO_3^-) salts are soluble
2. Salts containing the **alkali metal** ions (Li^+, Na^+, K^+, Rb^+, Cs^+) and the **ammonium** ion (NH_4^+) are soluble
3. Most **chloride**, **bromide**, and **iodide** salts are soluble. Notable exceptions are salts containing the ions Ag^+, Pb^{2+}, Hg_2^{2+}
4. Most **sulfate** salts are soluble. Notable exceptions are $BaSO_4$, $PbSO_4$, Hg_2SO_4 and $CaSO_4$.
5. Most **hydroxide** salts are slightly soluble (insoluble). Exceptions include $Ba(OH)_2$, $Sr(OH)_2$, and $Ca(OH)_2$.
6. Most **sulfide** (S^{2-}), **carbonate** (CO_3^{2-}), **chromate** (CrO_4^{2-}), and **phosphate** (PO_4^{3-}) salts are insoluble.

Molecular Equation: $2KCl\,(aq) + Pb(NO_3)_2\,(aq) \rightarrow 2KNO_3\,(aq) + PbCl_2\,(s)$

Complete Ionic Equation: $2K^+\,(aq) + 2Cl^-\,(aq) + Pb^{2+}\,(aq) + 2NO_3^-\,(aq) \rightarrow 2K^+\,(aq) + 2NO_3^-\,(aq) + PbCl_2\,(s)$

~~$2K^+\,(aq)$~~ $+ 2Cl^-\,(aq) + Pb^{2+}\,(aq) +$ ~~$2NO_3^-\,(aq)$~~ $\rightarrow$ ~~$2K^+\,(aq)$~~ $+$ ~~$2NO_3^-\,(aq)$~~ $+ PbCl_2\,(s)$

Net Ionic Equation: $2Cl^-\,(aq) + Pb^{2+}\,(aq) \rightarrow PbCl_2\,(s)$

Write the <u>complete ionic equation</u> and cross out the spectator ions to give the <u>net ionic equation</u> for each of the reactions below. Include <u>physical states</u> for each species.

1. $LiCl(\ ) + AgNO_3(\ ) \rightarrow AgCl(\ ) + LiNO_3(\ )$
2. $Na_2S(\ ) + CaCl_2(\ ) \rightarrow 2NaCl(\ ) + CaS(\ )$
3. $ZnCl_2(\ ) + 2KOH(\ ) \rightarrow Zn(OH)_2(\ ) + 2KCl(\ )$
4. $Na_2CO_3(\ ) + Co(NO_3)_2(\ ) \rightarrow 2NaNO_3(\ ) + CoCO_3(\ )$
5. $2NaOH(\ ) + MnBr_2(\ ) \rightarrow 2NaBr(\ ) + Mn(OH)_2(\ )$
6. $FeCl_3(\ ) + (NH_4)_3PO_4(\ ) \rightarrow 3NH_4Cl(\ ) + FePO_4(\ )$

Write the net ionic equation for each of the following reactions. List all spectator ions.

7. A solution of aluminum bromide, $AlBr_3$ reacts with a solution of sodium hydroxide, NaOH to form the precipitate aluminum hydroxide, $Al(OH)_3$.
8. Aqueous copper (II) nitrate, $Cu(NO_3)_2$ reacts with aqueous potassium carbonate, K_2CO_3 forming solid copper (II) carbonate, $Cu(CO_3)$.
9. A solution of barium chloride, $BaCl_2$ reacts with a solution of magnesium sulfate, $MgSO_4$ to form the precipitate barium sulfate, $BaSO_4$.
10. Aqueous potassium sulfide, K_2S reacts with a solution of cadmium chloride, $CdCl_2$ to form solid cadmium sulfide, CdS.

1) $LiCl + AgNO_3 \rightarrow AgCl_{(s)} + LiNO_3$

$Li^+ + Cl^- + Ag^+ + NO_3^- \rightarrow AgCl_{(s)} + Li^+ + NO_3^-$

$Ag^+ + Cl^- \rightarrow AgCl_{(s)}$

2) $Na_2S + CaCl_2 \rightarrow CaS_{(s)} + 2NaCl$

$2Na^+ + S^{2-} + Ca^{2+} + 2Cl^- \rightarrow$

$CaS_{(s)} + 2Na^+ + 2Cl^-$

$Ca^{2+} + S^{2-} \rightarrow CaS_{(s)}$

3) $ZnCl_2 + 2KOH \rightarrow Zn(OH)_{2(s)} + 2KCl$

$Zn^{2+} + 2Cl^- + 2K^+ + 2OH^- \rightarrow$

$Zn(OH)_{2(s)} + 2K^+ + 2Cl^-$

$Zn^{2+} + 2OH^- \rightarrow Zn(OH)_{2(s)}$

4) $Na_2CO_3 + Co(NO_3)_2 \rightarrow$

$2NaNO_3 + CoCO_{3(s)}$

$CO_3^{2-} + 2Na^+ + Co^{2+} + 2NO_3^- \rightarrow$

$2Na^+ + 2NO_3^- + CoCO_{3(s)}$

$Co^{2+} + CO_3^{2-} \rightarrow CoCO_{3(s)}$

5) $2NaOH + MnBr_2 \rightarrow$

$2NaBr + Mn(OH)_{2(s)}$

$2Na^+ + 2OH^- + Mn^{2+} + 2Br^- \rightarrow$

$2Na^+ + 2Br^- + Mn(OH)_{2(s)}$

$Mn^{2+} + 2OH^- \rightarrow Mn(OH)_{2(s)}$

6) $FeCl_3 + (NH_4)_3PO_4 \rightarrow$

$FePO_{4(s)} + 3NH_4Cl$

$Fe^{3+} + 3Cl^- + 3NH_4^+ + PO_4^{3-} \rightarrow$

$FePO_{4(s)} + 3NH_4^+ + 3Cl^-$

$Fe^{3+} + PO_4^{3-} \rightarrow FePO_{4(s)}$

7) $AlBr_3 + 3NaOH \rightarrow Al(OH)_{3(s)} + 3NaBr$

$Al^{3+} + 3Br^- + 3Na^+ + 3OH^- \rightarrow$

$Al(OH)_{3(s)} + 3Na^+ + 3Br^-$

$Al^{3+} + 3OH^- \rightarrow Al(OH)_{3(s)}$

8) $Cu(NO_3)_2 + K_2CO_3 \rightarrow$

$CuCO_{3(s)} + 2KNO_3$

$Cu^{2+} + 2NO_3^- + 2K^+ + CO_3^{2-} \rightarrow$

$CuCO_{3(s)} + 2K^+ + 2NO_3^-$

$Cu^{2+} + CO_3^{2-} \rightarrow CuCO_{3(s)}$

9) $BaCl_2 + MgSO_4 \rightarrow BaSO_4 + MgCl_2$

$Ba^{2+} + 2Cl^- + Mg^{2+} + SO_4^{2-} \rightarrow$

$BaSO_{4(s)} + Mg^{2+} + 2Cl^-$

$Ba^{2+} + SO_4^{2-} \rightarrow BaSO_{4(s)}$

10) $K_2S + CdCl_2 \rightarrow CdS + 2KCl$

$2K^+ + S^{2-} + Cd^{2+} + 2Cl^- \rightarrow$

$CdS + 2K^+ + 2Cl^-$

$Cd^{2+} + S^{2-} \rightarrow CdS_{(s)}$