Name _____ Class _____ Date _____

Types of Chemical Reactions

Section Review 8.2

DIRECTIONS: Write on the line at the right of each statement the letter preceding the word or expression that best completes the statement.

1. The reaction $2Mg(s) + O_2(g) \rightarrow 2MgO(s)$ is an example of a(n) (a) synthesis reaction; (b) decomposition reaction; (c) single-replacement reaction; (d) double-replacement reaction. _____ 1
2. The reaction $Mg(s) + HCl(aq) \rightarrow H_2(g) + MgCl_2(aq)$ is an example of a(n) (a) combustion reaction; (b) decomposition reaction; (c) single-replacement reaction; (d) double-replacement reaction. _____ 2
3. The equation $2HgO(s) \rightarrow 2Hg(\ell) + O_2(g)$ is an example of a(n) (a) single-replacement reaction; (b) synthesis reaction; (c) ionic reaction; (d) decomposition reaction. _____ 3
4. In one type of synthesis reaction, an element combines with oxygen to yield a(n) (a) acid; (b) hydroxide; (c) oxide; (d) metal. _____ 4
5. A metal carbonate, when heated, decomposes into a metal oxide and (a) carbon; (b) carbon dioxide; (c) oxygen; (d) hydrogen. _____ 5
6. In the equation $2Al(s) + 3Fe(NO_3)_2(aq) \rightarrow 3Fe(s) + 2Al(NO_3)_3(aq)$, iron has been replaced by (a) nitrate; (b) water; (c) aluminum; (d) nitrogen. _____ 6
7. The replacement of bromine by chlorine in a salt is an example of a single-replacement reaction by (a) halogens; (b) sodium; (c) water; (d) electrolysis. _____ 7
8. The reaction of calcium oxide (CaO) with water will yield (a) calcium and oxygen gas; (b) calcium hydroxide; (c) calcium and a salt; (d) carbon dioxide and water. _____ 8
9. Predict the product of the following reaction. $MgO + CO_2 \rightarrow$ (a) $MgCO_3$ (b) $Mg + CO_3$ (c) $MgC + O_3$ (d) $MgCO_2 + O$ _____ 9
10. What product(s) will result from the decomposition of HgO? (a) mercury(I) oxide (b) mercury and oxygen (c) mercury hydroxide (d) only mercury _____ 10

DIRECTIONS: Write on the line at the right of each statement the word or expression that best completes the meaning when substituted for the corresponding number.

11. A reaction in which two or more substances combine to form a new substance is called a(n) __(11)__ reaction. _____ 11
12. The equation $AX \rightarrow A + B$ is the general equation for a(n) __(12)__ reaction. _____ 12
13. A reaction in which one element replaces a similar element in a compound is called a(n) __(13)__ reaction. _____ 13
14. __(14)__ is the decomposition of a substance by an electric current. _____ 14
15. Group-1 metals react with water to produce __(15)__ and metal hydroxides. _____ 15

Name _____ Date _____ Class _____

CHAPTER 9 REVIEW ACTIVITY

Text Reference: **Section 9-12**

Categories of Chemical Reactions

State whether each of the following equations represents a synthesis (s), analysis (a), single replacement (sr), or double replacement (dr) reaction.

1.	$CO_2 \rightarrow C + O_2$	**1.** _____
2.	$NaCl + AgNO_3 \rightarrow NaNO_3 + AgCl$	**2.** _____
3.	$S + Cl_2 \rightarrow SCl_2$	**3.** _____
4.	$BaCl_2 + 2NaOH \rightarrow 2NaCl + Ba(OH)_2$	**4.** _____
5.	$Zn + CuSO_4 \rightarrow ZnSO_4 + Cu$	**5.** _____
6.	$CH_4 \rightarrow C + 2H_2$	_____
7.	$Pb(NO_3)_2 + Mg \rightarrow Pb + Mg(NO_3)_2$	**7.** _____
8.	$Mg + 2HCl \rightarrow MgCl_2 + H_2$	**8.** _____
9.	$H_2SO_4 \rightarrow H_2 + S + 2O_2$	**9.** _____
10.	$2O_2 + N_2 \rightarrow N_2O_4$	**10.** _____
11.	$3CaBr_2 + 2Na_3P \rightarrow Ca_3P_2 + 6NaBr$	**11.** _____
12.	$2KI + Br_2 \rightarrow 2KBr + I_2$	**12.** _____
13.	$C_6H_{12}O_6 \rightarrow 6C + 6H_2O$	**13.** _____
14.	$2NaF \rightarrow 2Na + F_2$	**14.** _____
15.	$Si + O_2 \rightarrow SiO_2$	**15.** _____
16.	$2NaI + Pb(NO_3)_2 \rightarrow 2NaNO_3 + PbI_2$	**16.** _____
17.	$NaI + Cs \rightarrow CsI + Na$	**17.** _____
18.	$H_2 + CO + O_2 \rightarrow H_2CO_3$	**18.** _____
19.	$Li_3PO_4 \rightarrow 3Li + P + 2O_2$	**19.** _____
20.	$CS_2 + 2F_2 \rightarrow CF_4 + 2S$	**20.** _____

Name _____ Class _____ Date _____

Chemical Equations

Section Review 8.1

DIRECTIONS: Write on the line at the right of each statement the letter preceding the word or expression that best completes the statement.

1. The actual knowledge about what products are produced in a chemical reaction is obtained by (a) inspecting the chemical equation; (b) balancing the chemical equation; (c) laboratory analysis; (d) writing a word equation. _____ 1
2. Once the correct formula for a reactant in an equation has been written, the (a) subscripts are adjusted to balance the equation; (b) formula should not be changed; (c) same formula must appear as a product; (d) symbols used in the formula must not be used on the product side of the equation. _____ 2
3. In writing an equation in which hydrogen gas appears as a product, the correct representation of hydrogen gas is (a) H; (b) 2H; (c) H_2; (d) OH. _____ 3
4. In a chemical equation, the symbol "→" is read (a) aqueous; (b) goes; (c) yields; (d) points. _____ 4
5. In a chemical equation, the upward pointing arrow is used for a(n) (a) heated reactant; (b) gaseous reactant; (c) catalyst; (d) gaseous product. _____ 5
6. How would oxygen be represented in the formula equation for the reaction of methane and oxygen to yield carbon dioxide and water? (a) oxygen (b) O (c) O_2 (d) O_3 _____ 6
7. What is the ratio of hydrogen to chlorine in the equation $H_2(g) + Cl_2(g) \rightarrow 2HCl(g)$? (a) 1:2 (b) 2:1 (c) 1:1 (d) 4:2 _____ 7
8. Balanced formula equations express all of the following EXCEPT (a) experimentally established facts; (b) mechanisms by which reactants become restructured into products; (c) identities of reactants and products in a chemical system; (d) relative quantities of reactants and products in the system. _____ 8
9. A reversible reaction is indicated by (a) a capital R; (b) a lower-case r; (c) an up and down arrow; (d) two yield symbols pointing in opposite directions. _____ 9
10. When the equation $Fe_3O_4 + Al \rightarrow Al_2O_3 + Fe$ is correctly balanced, the coefficient of Fe is (a) 3; (b) 4; (c) 6; (d) 9. _____ 10

DIRECTIONS: Write the answers to the following on the lines provided. Where appropriate, make complete statements.

11. In a chemical equation, the symbol "(s)" indicates that the substance is a(n) _____. 11
12. Write the word equation that represents the production of water from hydrogen and oxygen. _____ 12

DIRECTIONS: Write the answers to the following in the space provided.

13. Write the formula equation for the formation of carbon dioxide from carbon and oxygen. 13

14. Balance the formula equation $NH_4NO_2 \rightarrow N_2(g) + H_2O$. 14

15. Balance the formula equation $CaO + H_2O \rightarrow Ca(OH)_2$. 15

Name _____ Class_____ Date_____

Activity 3-8
Chemical Equations I
Introduction

A chemical equation is a concise statement of facts about a chemical reaction. It always identifies the reactants and products and gives the relative numbers of atoms, ions, and molecules involved in the reaction. It may also include additional information about energy changes and phase.

The equation below describes the burning of methane, the primary component of natural gas.

$$CH_4 + 2O_2 - CO_2 + 2H_2O$$

1. The names of the reactants are _____ and _____.

   The names of the products are _____ and _____.

2. Several ratios of molecules can be determined from the equation. Write numbers in the blanks to indicate the ratios of molecules.

   $\frac{\text{\_\_\_\_\_ molecule(s) } O_2}{\text{\_\_\_\_\_ molecule(s) } CH_4}$ $\frac{\text{\_\_\_\_\_ molecule(s) } O_2}{\text{\_\_\_\_\_ molecule(s) } H_2O}$ $\frac{\text{\_\_\_\_\_ molecule(s) } CO_2}{\text{\_\_\_\_\_ molecule(s) } CH_4}$

3. Why is the equation above a balanced equation? Choose *a* or *b* for your answer and circle the letter of your choice.
   a. The total number of molecules of reactants is equal to the total number of molecules of products.
   b. For each element, the number of atoms represented as reactants is equal to the number of atoms represented as products.
4. Is the equation below balanced?_____

$$P_4 + 5O_2 - P_4O_{10}$$

   Account for your answer. _____

   _____

   Notice that six molecules of reactants are changed into one molecule of product. Is this consistent with the law of conservation of mass? Account for your answer._____

   _____

   _____

5. How many different oxygen atoms are represented in the equation in question 4? _____ The correct answer is 10 (not 20). Account for the correct answer.

   _____

   _____

Writing balanced chemical equations

Writing balanced chemical equations is a three-step process:

- Identify or name each of the reactants and products. They may be elements, ionic compounds, or molecular compounds.
- Write the *correct* formula for each reactant and product. These formulas may be simply the symbol for an uncombined atom or they may be empirical or molecular formulas for compounds.
- Adjust the coefficients in the equation to maintain conservation of atoms. Be careful not to confuse subscript numerals inside formulas with the coefficients that precede the formulas in the equation.

6. Balance the following equations by adjusting the coefficients to maintain conservation of atoms. Note that the correct chemical formulas for reactants and products have been provided. Water is sometimes written as HOH when hydroxide compounds are involved in chemical change. Usually when a coefficient is determined to be "1", no numeral is written. However, throughout this unit we may use the numeral "1" to help in balancing.

a. _____ HCl + _____ $Ca(OH)_2$ → _____ $CaCl_2$ + _____ HOH

b. _____ Fe + _____ Cl_2 → _____ $FeCl_3$

c. _____ Mg + _____ N_2 → _____ Mg_3N_2

d. _____ $FeCl_3$ + _____ Na_3PO_4 → _____ $Fe_3(PO_4)_2$ + _____ $NaCl$

e. _____ $AgNO_3$ + _____ $AlCl_3$ → _____ $AgCl$ + _____ $Al(NO_3)_3$

7. Ethyl alcohol (C_2H_5OH) burns to form carbon dioxide and water, as follows:

$$C_2H_5OH + 3O_2 \rightarrow 2CO_2 + 3H_2O$$

Do the coefficients used give a balanced equation? _____ Account for your answer. _____

_____

_____

8. Butyl alcohol (C_4H_9OH) burns to form the same products. Balance the equation below by adjusting the coefficients to maintain conservation of atoms.

_____ C_4H_9OH + _____ O_2 → _____ CO_2 + _____ H_2O

9. Sodium sulfide will react with copper (II) chloride to form sodium chloride and copper (II) sulfide. Follow the steps above to write a balanced equation for that chemical change.

_____

Both reactants and both products are ionic compounds. How many of each kind of ion did you represent?

Na^+ _____ S^{2-} _____ Cu^{2+} _____ Cl^- _____

What is the sum of the coefficients of the reactants?_____

What is the sum of the coefficients of the products?_____

Write formulas for and balance the following:

1. magnesium bromide(aq) + chlorine(g) ⟶ magnesium chloride(aq) + bromine(g)
2. sodium(c) + water(l) ⟶ sodium hydroxide(aq) + hydrogen(g)
3. potassium nitrate(c) ⟶ potassium nitrite(c) + oxygen(g)
4. zinc(c) + hydrochloric acid(aq) ⟶ zinc chloride(aq) + hydrogen(g)
5. calcium oxide(c) + hydrochloric acid(aq) ⟶ calcium chloride(aq) + water(l)

Write balanced equations for each of the following chemical reactions.

6. $Mg(c) + O_2(g) \longrightarrow MgO(c)$
7. $Fe(c) + O_2(g) \longrightarrow Fe_2O_3(c)$
8. $H_2O(l) + N_2O_3(g) \longrightarrow HNO_2(aq)$
9. $Na_2O(c) + H_2O(l) \longrightarrow NaOH(aq)$
10. $Fe(c) + H_2O(l) \longrightarrow Fe_3O_4(c) + H_2(g)$

Balance the following equations.

11. $KClO_3(c) \longrightarrow KCl(c) + O_2(g)$
12. $PbO_2(c) \longrightarrow PbO(c) + O_2(g)$
13. $HgO(c) \longrightarrow Hg(l) + O_2(g)$
14. $H_2O(l) \longrightarrow H_2(g) + O_2(g)$
15. $Al(c) + Pb(NO_3)_2(aq) \longrightarrow Al(NO_3)_3(aq) + Pb(c)$
16. $Cu(c) + AgNO_3(aq) \longrightarrow Cu(NO_3)_2(aq) + Ag(c)$
17. $K(c) + H_2O(l) \longrightarrow KOH(aq) + H_2(g)$
18. $MnO_2(c) + HCl(aq) \longrightarrow MnCl_2(aq) + Cl_2(g) + H_2O(l)$
19. $Cl_2(g) + LiI(aq) \longrightarrow LiCl(aq) + I_2(g)$
20. $Ca(OH)_2(aq) + HCl(aq) \longrightarrow CaCl_2(aq) + H_2O(l)$
21. $KOH(aq) + H_3PO_4(aq) \longrightarrow K_3PO_4(aq) + H_2O(l)$
22. $Al(NO_3)_3(aq) + H_2SO_4(aq) \longrightarrow Al_2(SO_4)_3(aq) + HNO_3(aq)$
23. $Na_2SO_3(aq) + HCl(aq) \longrightarrow NaCl(aq) + H_2O(l) + SO_2(g)$
24. $(NH_4)_2SO_4(aq) + KOH(aq) \longrightarrow K_2SO_4(aq) + NH_3(g) + H_2O(l)$
25. $Pb(NO_3)_2(aq) + K_2S(aq) \longrightarrow PbS(c) + KNO_3(aq)$

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Activity 3-11
Practice Drill: Chemical Equations

Complete and balance the following equations for chemical reactions. In the space at the right of each equation, identify the category of reaction. Use:

SYN—synthesis
DEC—decomposition
SR—single replacement

1. ____$Al(s)$ + ____$Br_2(g)$ → ____ _____ 1. _____
2. ____$O_2(g)$ + ____ _____ → ____$Fe_2O_3(s)$ 2. _____
3. ____$Zn(s)$ + ____$HCl(aq)$ → ____ _____ + ____ _____ 3. _____
4. ____ Mg + ____H_3PO_4 → ____ _____ + ____ _____ 4. _____
5. ____$NH_4OH(aq)$ → ____$NH_3(g)$ + ____ _____ 5. _____
6. ____$Al_2O_3(s)$ → ____$Al(s)$ + ____ _____ 6. _____
7. ____$KClO_3(s)$ → ____$O_2(g)$ + ____ _____ 7. _____
8. ____$K(s)$ + ____$HOH(l)$ → ____ _____ + ____$KOH(aq)$ 8. _____
9. ____$Ba(s)$ + ____ _____ → ____$Ba_3N_2(s)$ 9. _____
10. ____$Cu(s)$ + ____ _____ → ____$Cu_2S(s)$ 10. _____

Complete and balance the following equations for chemical reactions.

11. ____$AlI_3(aq)$ + ____$HgCl_2(aq)$ → ____ _____ + ____ _____
12. ____$FeCl_3(aq)$ + ____$H_3PO_4(aq)$ → ____ _____ + ____ _____
13. ____$SnCl_4(aq)$ + ____ _____ → ____$NH_4Cl(aq)$ + ____$SnS_2(s)$
14. ____$CaBr_2(aq)$ + ____$KOH(aq)$ → ____ _____ + ____ _____
15. ____$AgNO_3(aq)$ + ____ _____ → ____$Ag_3PO_4(s)$ + ____$KNO_3(aq)$
16. ____ _____ + ____$Ba(OH)_2(aq)$ → ____$Al(OH)_3(s)$ + ____$BaCl_2(aq)$
17. ____$Ca(C_2H_3O_2)_2(aq)$ + ____ _____ → ____$CaCO_3(s)$ + ____$NaC_2H_3O_2(aq)$
18. ____ $Na_3PO_4(aq)$ + ____ $ZnSO_4$ (aq) → ____ _____ + ____ _____
19. ____$Ba(ClO_3)_2(aq)$ + ____$Na_2S(aq)$ → ____ _____ + ____ _____
20. ____ _____ + ____$AlCl_3(aq)$ → ____$KCl(aq)$ + ____$Al_2(CrO_4)_3(s)$
21. ____$(NH_4)_2CO_3(aq)$ + ____$NaOH(aq)$ → ____ _____ + ____$NH_3(g)$ + ____ _____
22. ____$K_2SO_3(aq)$ + ____$HNO_3(aq)$ → ____ _____ + ____ _____ + ____$H_2O(l)$
23. ____ _____ + ____$HNO_3(aq)$ → ____$Ca(NO_3)_2(aq)$ + ____ $H_2O(l)$
24. ____$Hg_2(NO_3)_2(aq)$ + ____ _____(aq) → ____ $Hg_2I_2(s)$ + ____$NaNO_3(aq)$

To which category do all these reactions belong? _____

Write balanced chemical equations for each of the following double replacement reactions.

25. calcium iodide + sulfuric acid →

_____

26. manganese sulfide + lead (IV) chloride →

_____

27. potassium hydroxide + iron (III) chloride →

_____

28. zinc bromide + sodium carbonate →

_____

29. calcium hydroxide + mercuric chloride →

_____

30. barium carbonate + sulfuric acid →

_____

31. potassium hydroxide + ammonium sulfate →

_____

32. sodium sulfite + hydrogen chloride →

_____

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Activity 3-10
Categories of Chemical Reactions

Many chemical reactions can be classified into one of these four categories:

- Direct combination or synthesis.
- Decomposition or analysis.
- Single replacement.
- Double replacement.

Direct combination or synthesis

A direct combination or synthesis reaction occurs when a compound is prepared from its elements or from simpler compounds.

1. What is the definition of *synthesis* as given in a dictionary? _____

   _____

   _____

   What is the definition of *synthesis* given in the glossary of your textbook? _____

   _____

   _____

2. The reaction

$$2Mg(s) + O_2(g) \rightarrow 2MgO(s)$$

   is classified as a direct combination or synthesis reaction because the elements _____ and _____ react to produce the compound _____.

3. The reaction

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

   is classified as a synthesis reaction because _____

   _____

Decomposition or analysis

A decomposition or analysis reaction occurs when a compound is decomposed into its elements or into simpler compounds.

4. What is the definition of *analysis* as given in a dictionary? _____

   _____

   _____

   What is the definition of *analysis* as given in the glossary of your textbook? _____

   _____

   _____

5. The reaction

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

is classified as a decomposition or analysis reaction because the compound _____ _____ is converted into the simpler compounds _____ and _____.

6. The reaction

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

is classified as an analysis reaction because _____

_____

_____

Single replacement

A single replacement reaction occurs when an element reacts with a compound to produce a different element and a different compound.

7. Some metals can replace other metals or hydrogen from binary and ternary compounds. Complete and balance the following equations for single replacement reactions.

   a. ____$AgNO_3(aq)$ + ____ _____ → ____$Cu(NO_3)_2(aq)$ + ____ _____

   b. ____$Mg(s)$ + ____ _____ (aq) → ____$Mg_3(PO_4)_2(s)$ + ____ $H_2(g)$

   c. ____$Zn(s)$ + ____$FeCl_3(aq)$ → ____ _____ + ____ _____

   d. ____$Cr(s)$ + ____$Pb(NO_3)_2(aq)$ → ____ _____ + ____ _____

8. Some nonmetals can replace other nonmetals from binary compounds. Complete and balance the following equations for single replacement reactions.

   a. ____$NaBr(aq)$ + ____$Cl_2(g)$ → ____ _____ (aq) + ____$Br_2(aq)$

   b. ____$AlI_3(aq)$ + ____$Br_2(g)$ → ____ _____ (aq) + ____$I_2(aq)$

Double replacement

A double replacement reaction may occur when solutions of certain ionic compounds are mixed with each other. If the mixing produces one or more of the following results, a double replacement reaction has taken place.

- The formation of water molecules, usually from the joining of H^+ and OH^- ions, for example:

$$HCl(aq) + KOH(aq) \rightarrow KCl(aq) + HOH(l)$$

  Note how water is written as HOH to emphasize the bonding of H^+ with OH^-.

- The formation of an insoluble product, called a precipitate, which settles out of the reaction mixture into the solid phase, for example:

$$Pb(NO_3)_2(aq) + 2HCl(aq) \rightarrow PbCl_2(s) + 2HNO_3(aq)$$

  (Refer to Table C in the Appendix for information.)

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- The formation of a gas that escapes from the reaction mixture. Three gases often formed are CO_2, SO_2, and NH_3. For example, if the reaction:

$$2HCl(aq) + K_2CO_3(aq) \rightarrow 2KCl(aq) + H_2CO_3(aq)$$

is carried out in an open test tube or flask, the product H_2CO_3 will react further to form H_2O and CO_2 until all of the H_2CO_3 is used up. We can write the equation for the complete reaction as follows:

$$2HCl(aq) + K_2CO_3(aq) \rightarrow 2KCl(aq) + H_2O(l) + CO_2(g)$$

It is convenient to write the formula H_2CO_3 to write the equation. However, H_2CO_3 should be changed to $H_2O(l) + CO_2(g)$ in the completed equation. Similarly, when H_2SO_3 appears to be the product of a double replacement, it should be written $H_2O(l) + SO_2(g)$ in the completed equation. Also, when NH_4OH is one of the products, it should be written $NH_3(g) + H_2O(l)$ in the completed equation.

9. Complete and balance each of the following double replacement reactions, in which water is a product.

   a. ____ _____ + ____$KOH(aq)$ → ____$HOH(l)$ + ____$K_3PO_4(aq)$

   b. ____$HC_2H_3O_2(aq)$ + $Ca(OH)_2(aq)$ → ____ $HOH(l)$ + ____ _____

   c. ____$HCl(aq)$ + ____ _____ → ____$BaCl_2(aq)$ + ____$HOH(l)$

10. Complete and balance each of the following double replacement reactions, in which an insoluble compound (precipitate) is a product.

   a. ____$AgNO_3(aq)$ + ____$Na_2CO_3(aq)$ → ____ _____(s) + ____$NaNO_3(aq)$

   b. ____ _____ + ____ _____ → ____$AlPO_4(s)$ + ____ $KCl(aq)$

   c. ____ $BaCl_2(aq)$ + ____$Na_2CrO_4(aq)$ → ____ _____(s) + ____$NaCl(aq)$

11. Complete and balance each of the following double replacement reactions, in which a gas is produced.

   a. ____$Na_2SO_3(aq)$ + ____$HNO_3(aq)$ → ____ _____ + ____ _____(g) + ____$H_2O(l)$

   b. ____$(NH_4)_3PO_4(aq)$ + ____$KOH(aq)$ → ____ _____ + ____$H_2O(l)$ + ____ _____ (g)

   c. ____ _____ + ____ _____ → ____$CO_2(g)$ + ____ $H_2O(l)$ + ____$ZnCl_2(aq)$

Ionic equations

In many chemical reactions, some or all of the reactants and products may be ions, rather than molecules or atoms. Equations for single replacement and double replacement reactions are often written as ionic equations. Ionic equations can then be converted into net ionic equations by the omission of spectator ions.

Single Replacement Reaction $2HCl(aq) + Zn(s) \rightarrow ZnCl_2(aq) + H_2(g)$

Ionic Equation $2H^+(aq) + 2Cl^-(aq) + Zn(s) \rightarrow Zn^{2+}(aq) + 2Cl^-(aq) + H_2(g)$

Net Ionic Equation $2H^+(aq) + Zn(s) \rightarrow Zn^{2+}(aq) + H_2(g)$

12. For each reaction below, balance the single replacement equation and convert it into ionic and net ionic equations.

a. ____$Cl_2(g)$ + ____$NaI(aq)$ → ____$I_2(g)$ + ____$NaCl(aq)$

Ionic equation _____

Net ionic equation _____

b. ____$Al(s)$ + ____$H_2SO_4(aq)$ → ____$Al_2(SO_4)_3(aq)$ + ____$H_2(g)$

Ionic equation _____

Net ionic equation _____

c. ____$Cu(NO_3)_2(aq)$ + ____$Zn(s)$ → ____$Zn(NO_3)_2(aq)$ + ____$Cu(s)$

Ionic equation _____

Net ionic equation _____

Double Replacement Reaction $BaCl_2(aq) + K_2CrO_4(aq) \rightarrow BaCrO_4(s) + 2KCl(aq)$

Ionic Equation $Ba^{2+}(aq) + 2Cl^-(aq) + 2K^+(aq) + CrO_4^{2-}(aq) \rightarrow BaCrO_4(s) + 2K^+(aq) + 2Cl^-(aq)$

Net Ionic Equation $Ba^{2+}(aq) + CrO_4^{2-}(aq) \rightarrow BaCrO_4(s)$

13. For each reaction below, balance the double replacement equation and convert it into ionic and net ionic equations.

a. ____$H_3PO_4(aq)$ + ____$KOH(aq)$ → ____$K_3PO_4(aq)$ + ____$HOH(l)$

Ionic equation _____

Net ionic equation _____

b. ____$AgNO_3(aq)$ + ____$CaCl_2(aq)$ → ____$AgCl(s)$ + ____$Ca(NO_3)_2(aq)$

Ionic equation _____

Net ionic equation _____

c. ____$Na_2CO_3(aq)$ + ____$HCl(aq)$ → ____$NaCl(aq)$ + ____$HOH(l)$ + ____$CO_2(g)$

Ionic equation _____

Net ionic equation _____

Equations

Write a balanced chemical equation to represent each of the following chemical reactions:

1. iron + sulfur → iron (II) sulfide

2. zinc + cupric sulfate → zinc sulfate + copper

3. silver nitrate + sodium bromide → sodium nitrate + silver bromide

4. potassium chlorate (heated) → potassium chloride + oxygen

5. water (electricity) → hydrogen + oxygen

6. mercury (II) oxide (heated) → mercury + oxygen

7. potassium iodide + lead (II) nitrate → lead (II) iodide + potassium nitrate

8. aluminum + oxygen → aluminum oxide

9. magnesium chloride + ammonium nitrate → magnesium nitrate + ammonium chloride

10. iron (III) chloride + ammonium hydroxide → iron (III) hydroxide + ammonium chloride

11. sodium peroxide + water → sodium hydroxide + oxygen

12. iron (III) oxide + carbon → iron + carbon monoxide

13. iron + water → hydrogen + iron (III) oxide

14. iron (III) chloride + potassium hydroxide → potassium chloride + iron (III) hydroxide

15. aluminum + sulfuric acid → aluminum sulfate + hydrogen

(continued)

16. sodium carbonate + calcium hydroxide → sodium hydroxide + calcium carbonate

17. carbon dioxide + water → carbonic acid

18. phosphorus + oxygen → phosphorus pentoxide

19. sodium + water → sodium hydroxide + hydrogen

20. zinc + sulfuric acid → zinc sulfate + hydrogen

21. aluminum sulfate + calcium hydroxide → aluminum hydroxide + calcium sulfate

22. calcium oxide + water → calcium hydroxide

23. iron + copper (I) nitrate → iron (II) nitrate + copper

24. iron (II) sulfide + hydrochloric acid → hydrogen sulfide + iron (II) chloride

25. potassium oxide + water → potassium hydroxide

26. ammonium sulfide + lead (II) nitrate → ammonium nitrate + lead (II) sulfide

27. mercury (II) hydroxide + phosphoric acid → mercury (II) phosphate + water

28. potassium hydroxide + phosphoric acid → potassium phosphate + water

29. calcium chloride + nitric acid → calcium nitrate + hydrochloric acid

30. potassium carbonate + barium chloride → potassium chloride + barium carbonate

31. magnesium hydroxide + sulfuric acid → magnesium sulfate + water

32. sulfur dioxide + water → sulfurous acid

(continued)

33. sodium carbonate + hydrochloric acid → sodium chloride + water + carbon dioxide

34. magnesium + nitric acid → magnesium nitrate + hydrogen

35. aluminum + iron (III) oxide → aluminum oxide + iron

36. potassium phosphate + magnesium chloride → magnesium phosphate + potassium chloride

37. ammonia + oxygen → nitrogen + water

38. calcium carbonate (heated) → calcium oxide + carbon dioxide

39. sodium chloride + sulfuric acid → sodium sulfate + hydrochloric acid

40. fluorine + sodium hydroxide → sodium fluoride + oxygen + water

41. magnesium nitrate + calcium iodide → calcium nitrate + magnesium iodide

42. aluminum sulfate + ammonium bromide → aluminum bromide + ammonium sulfate

43. potassium fluoride + barium bromide → barium fluoride + potassium bromide

44. copper (II) nitrate + ammonium hydroxide → copper (II) hydroxide + ammonium nitrate

45. sodium nitrate (heated) → sodium nitrite + oxygen

46. lead (II) hydroxide (heated) → lead (II) monoxide + water

47. ammonia + sulfuric acid → ammonium sulfate

48. hydrochloric acid + ammonia → ammonium chloride

49. copper (II) sulfate + iron → iron (II) sulfate + copper

(continued)

50. aluminum + hydrochloric acid → aluminum chloride + hydrogen

51. carbon + oxygen → carbon dioxide

52. calcium bicarbonate + calcium hydroxide → calcium carbonate + water

53. hydrogen sulfide + oxygen → water + sulfur

54. sodium hydroxide + calcium nitrate → sodium nitrate + calcium hydroxide

55. potassium iodide + chlorine → potassium chloride + iodine

56. sulfuric acid + potassium hydroxide → potassium sulfate + water

57. carbon dioxide + carbon → carbon monoxide

58. calcium sulfate + sodium carbonate → calcium carbonate + sodium sulfate

59. water + diphosphorus pentoxide → phosphorus acid

60. aluminum + phosphoric acid → hydrogen + aluminum phosphate

61. ammonium chloride + sodium nitrite → sodium chloride + nitrogen + water

62. chlorine + sodium hydroxide → sodium chloride + sodium hypochlorite + water

63. lead (II) nitrate (heated) → lead [redacted] (II) oxide + nitrogen dioxide + oxygen

64. mercury (I) oxide + oxygen → mercury (II) oxide

65. calcium oxide + magnesium chloride → magnesium oxide + calcium chloride

66. calcium + water → calcium hydroxide + hydrogen

(continued)

67. chromium (III) chloride + sulfuric acid → chromium (III) sulfate + hydrochloric acid

68. iron (III) nitrate + ammonium hydroxide → iron (III) hydroxide + ammonium nitrate

69. aluminum chloride + potassium phosphate → aluminum phosphate + potassium chloride

70. aluminum oxide + carbon + chlorine → carbon monoxide + aluminum chloride

71. copper (I) oxide + hydrochloric acid → copper (I) chloride + water

72. magnesium bicarbonate + hydrochloric acid → magnesium chloride + water + carbon dioxide

73. iron + oxygen → iron (III) oxide

74. silicon + water (heat) → silicon dioxide + hydrogen

75. iron (III) oxide + carbon monoxide → iron + carbon dioxide

76. calcium chloride + chromium (III) nitrate → calcium nitrate + chromium (III) chloride

77. zinc sulfide + oxygen → zinc oxide + sulfur dioxide

78. calcium phosphate + sulfuric acid → calcium sulfate + phosphoric acid

79. iron (III) hydroxide (heated) → iron (III) oxide + water

80. aluminum sulfate + sodium bicarbonate → aluminum hydroxide + sodium sulfate + carbon dioxide

81. calcium phosphate + silicon dioxide + carbon → phosphorus + calcium silicate + carbon monoxide

82. calcium oxide + sulfur dioxide → calcium sulfite

(continued)

83. carbon dioxide + magnesium hydroxide → magnesium carbonate + water

84. calcium oxide + hydrochloric acid → calcium chloride + water

85. calcium carbonate + silicon dioxide → calcium silicate + carbon dioxide

86. antimony + chlorine → antimony trichloride

87. magnesium nitride + water → magnesium hydroxide + ammonia

88. arsenic + oxygen → arsenic (III) oxide

89. ammonium bicarbonate (heated) → ammonia + water + carbon dioxide

90. cupric oxide + ammonia → copper + water + nitrogen

91. ammonium dichromate (heated) → chromium trioxide + nitrogen + water

92. hydrogen sulfide + cadmium nitrate → nitric acid + cadmium sulfide

93. barium bromide + sodium phosphate → barium phosphate + sodium bromide

94. aluminum chloride + ammonium fluoride → aluminum fluoride + ammonium chloride

95. silver nitrate + potassium sulfate → silver sulfate + potassium nitrate

96. bismuth nitrate + calcium iodide → bismuth iodide + calcium nitrate

97. aluminum chromate + ammonium sulfate → ammonium chromate + aluminum sulfate

98. zinc nitrate + ammonium bromide → zinc bromide + ammonium nitrate

99. bismuth nitrate + ammonium hydroxide → bismuth hydroxide + ammonium nitrate

(continued)

100. cadmium nitrate + sulfuric acid → cadmium sulfate + nitric acid

101. zinc + silver iodide → zinc iodide + silver

102. iron (III) chloride + sulfuric acid → iron (III) sulfate + hydrochloric acid

103. bismuth sulfate + ammonium hydroxide → bismuth hydroxide + ammonium sulfate

104. hydrogen iodide + oxygen → iodine + water

105. potassium sulfate + barium chloride → barium sulfate + potassium chloride

106. barium sulfate + carbon → barium sulfide + carbon monoxide

107. aluminum oxide + hydrofluoric acid → aluminum fluoride + water

108. aluminum fluoride + sulfuric acid → aluminum sulfate + hydrogen fluoride

109. potassium iodide + hydrogen peroxide → potassium hydroxide + iodine

110. zinc + ferric sulfate → zinc sulfate + ferrous sulfate

111. lead (II) sulfide + lead monoxide → lead + sulfur dioxide

112. copper + sulfuric acid → copper (II) sulfate + water + sulfur dioxide

113. aluminum hydroxide (heated) → aluminum oxide + water

114. nitrogen + hydrogen → ammonia

115. sodium carbonate + carbonic acid → sodium bicarbonate

116. silicon dioxide + hydrofluoric acid → water + silicon tetrafluoride

(continued)

117. sodium hypochlorite → sodium chloride + sodium chlorate

118. sodium chlorite + chlorine → sodium chloride + chlorine dioxide

119. methane + sulfur dioxide (heated) → hydrogen sulfide + carbon dioxide + hydrogen

120. tellurous acid → tellurium dioxide + water

121. iron (II) selenide + hydrochloric acid → iron (II) chloride + hydrogen selenide

122. magnesium + nitrogen → magnesium nitride

123. silver cyanide + potassium → potassium cyanide + silver

124. copper (II) sulfate + ammonia → cupriammonia sulfate

125. calcium carbide + nitrogen → calcium cyanamide + carbon

126. calcium cyanamide + water → calcium carbonate + ammonia

127. zinc arsenide + hydrochloric acid → arsine + zinc chloride

128. lead (II) hydroxide + sodium stannite → lead + sodium stannate + water

129. sodium silicate + hydrochloric acid → sodium chloride + silicic acid

130. boron trioxide + magnesium → magnesium oxide + boron

131. iron (II) cyanide + potassium cyanide → potassium ferrocyanide

132. sodium aluminate + ammonium chloride → ammonium aluminum oxide + sodium chloride

133. aluminum hydroxide + sodium hydroxide → sodium aluminate + water

(continued)

134. tungsten + chlorine (300° C) → tungsten hexachloride

135. calcium + ammonia → calcium hydride + nitrogen

136. sodium wolframate + sulfuric acid → sodium sulfate + tungstic acid

137. lithium hydride + water → lithium hydroxide + hydrogen

138. boric acid → tetraboric acid + water

139. zinc hydroxide + potassium hydroxide → potassium zincate + water

140. nickel + carbon monoxide → nickel carbonyl

Name _____ Class _____ Date _____

Activity Series of the Elements

Section Review 8.3

DIRECTIONS: Write on the line at the right of each statement the letter preceding the word or expression that best completes the statement.

1. The ability of an element to react is referred to as the element's (a) valence; (b) activity; (c) stability; (d) electronegativity. _____ 1
2. An element in the activity series can replace any element (a) in the periodic table; (b) below it on the list; (c) above it on the list; (d) in its group. _____ 2
3. An activity series is useful because it allows a person to predict (a) whether or not a certain chemical reaction will occur; (b) the amount of energy released by a chemical reaction; (c) the electronegativity values of elements; (d) the melting points of elements. _____ 3
4. For a single-replacement reaction, an element will replace from a compound in aqueous solution those elements (a) above it in the activity series; (b) with lower atomic masses; (c) below it in the activity series; (d) with higher atomic numbers. _____ 4
5. To replace hydrogen from steam, a metal must be (a) above cobalt in the activity series; (b) below hydrogen in the activity series; (c) a halogen; (d) less reactive than lithium. _____ 5
6. In the activity series, any metal above hydrogen reacts with acids, replacing (a) hydrogen; (b) oxygen; (c) chlorine; (d) water. _____ 6
7. The synthesis of oxides by reaction with oxygen occurs for any metal in the activity series (a) below platinum; (b) above gold; (c) above silver; (d) below tin. _____ 7
8. Oxides are formed only indirectly by metals in the activity series (a) above zinc; (b) below calcium; (c) above tin; (d) below mercury. _____ 8
9. In the presence of oxygen (O_2), gold can be expected to (a) rapidly form an oxide; (b) slowly form an oxide; (c) not react; (d) rapidly form a metallic hydroxide. _____ 9
10. In the activity series, oxides of metals below copper (a) do not exist; (b) do not decompose; (c) decompose with heat alone; (d) are acidic. _____ 10
11. In the activity series, oxides of metals below chromium yield metals when (a) heated with hydrogen; (b) cooled below 0°C; (c) combined with oxygen; (d) added to acids. _____ 11
12. Since mercury is below copper in the activity series, heating HgO will result in (a) no reaction; (b) the formation of a hydroxide; (c) the formation of Hg_2O; (d) decomposition. _____ 12
13. Predict what will happen when calcium metal is added to a solution of magnesium chloride. (a) No reaction will occur. (b) Calcium chloride will form. (c) Magnesium calcite will form. (d) Gaseous calcium will be produced. _____ 13
14. Predict what will happen when zinc is added to water. (a) No reaction will occur. (b) Steam will be produced. (c) Zinc oxide will form. (d) Hydrogen will be released. _____ 14
15. Predict what will happen when lead is added to nitric acid. (a) No reaction will occur. (b) Oxygen will be released. (c) Lead oxide will form. (d) Hydrogen will be released. _____ 15

Reaction Prediction

In each of the following examples:

a. State what type of reaction is expected.
b. Tell whether the reaction will occur or not, and why.
c. Write the balanced equation for those reactions that do take place; write the symbols and formulas of the reactants for those reactions that do occur.
d. Indicate whether double replacement reactions are reversible or irreversible.

1. aluminum plus hydrochloric acid

2. calcium hydroxide plus nitric acid

3. aluminum plus magnesium

4. magnesium plus zinc nitrate

5. mercury plus oxygen

6. zinc chloride plus hydrogen sulfide

7. dinitrogen pentoxide plus water

8. silver chloride plus sodium nitrate

9. sodium chlorate (heated)

10. barium nitrate plus sodium chromate

11. sodium bromide plus silver nitrate

12. calcium phosphate plus aluminum sulfate

13. zinc carbonate (heated)

(continued)

14. mercury (I) sulfate plus ammonium nitrate

15. potassium plus fluorine

16. potassium nitrate plus zinc phosphate

17. lithium oxide plus water

18. sodium chloride (electrolyzed)

19. silver plus barium

20. iron (III) hydroxide plus phosphoric acid

21. sodium plus nitric acid

22. iron (III) iodide plus cupric nitrate

23. copper plus sulfuric acid

24. lead plus potassium chlorate

25. sulfur dioxide plus water

26. oxygen plus sulfur

27. sodium sulfate plus barium chloride

28. ammonium phosphate plus lithium hydroxide

29. hydrogen plus oxygen

30. mercury plus nitric acid

31. sodium oxide plus water

32. calcium carbonate plus lithium chloride

33. mercury (I) sulfate plus hydrochloric acid

34. potassium nitrate (heated)

35. chlorine plus bromine

36. mercury (I) nitrate plus sodium carbonate

37. magnesium plus hydrochloric acid

38. water (electrolyzed)

39. ammonium nitrite plus barium hydroxide

40. ammonium sulfate plus calcium hydroxide

41. mercury (II) oxide (heated)

42. ammonium phosphate plus aluminum chloride

43. barium oxide plus water

44. iron (III) hydroxide plus nitric acid

45. calcium plus oxygen

46. calcium plus phosphoric acid

(continued)

47. calcium chloride plus ammonium hydroxide

48. aluminum sulfide plus hydrochloric acid

49. magnesium plus sulfur

50. calcium plus aluminum chloride

51. potassium hydroxide plus hydrosulfuric acid

52. sodium carbonate plus sulfuric acid

53. barium sulfate plus calcium chloride

54. silver plus mercurous nitrate

55. barium carbonate (heated)

56. lithium plus bromine

57. sodium chloride plus potassium chromate

58. potassium sulfide plus iron (II) nitrate

59. iodine plus ammonium fluoride

60. sodium plus calcium

61. aluminum chloride (electrolyzed)

62. lead chlorate plus sodium sulfide

63. sulfur trioxide plus water

(continued)

64. calcium carbonate plus hydrochloric acid

65. iron plus sodium bromide

66. ammonium acetate plus iron (II) chloride

67. silver bromide plus ammonium sulfate

68. zinc plus sulfuric acid

69. neon plus potassium

70. iron plus potassium iodide

71. lead (II) hydroxide plus hydrochloric acid

72. iron plus sulfur

73. potassium chlorate (heated)

74. oxygen plus chlorine

75. silver iodide plus iron (III) sulfide

76. ferrous carbonate plus phosphoric acid

77. potassium iodide plus ammonium nitrate

78. potassium plus sodium nitrate (fused)

79. bromine plus sodium chloride

80. silver sulfide plus hydrochloric acid

(continued)

81. magnesium nitrate plus hydrochloric acid

82. ammonia plus hydrogen chloride

83. zinc hydroxide plus sulfuric acid

84. calcium oxide plus water

85. sodium plus chlorine

86. calcium hydroxide (heated)

87. fluorine plus potassium bromide

88. ammonium hydroxide plus sulfuric acid

89. sodium chloride plus potassium nitrate

90. lead plus tin (II) nitrate

91. carbon dioxide plus water

92. chlorine plus lithium bromide

93. lithium hydroxide plus phosphoric acid

94. potassium sulfite plus nitric acid

95. ammonium chloride plus potassium hydroxide

96. strontium carbonate plus nitric acid

97. tin plus mercury (I) nitrate

98. ammonium sulfite plus hydrochloric acid

99. magnesium carbonate plus phosphoric acid

100. aluminum sulfite plus hydrochloric acid