Names _____ Period _____ Date _____

Chemical Reactions, Equations & Symbols

A chemical reaction occurs when there is a chemical change that results in the formation of new substances. This is evident by a change in temperature (exothermic- give off heat; or endothermic-absorb heat), release of a gas, formation of a precipitate (solid that comes out of solution), and /or a change in color.

Examples:

$AgNO3(aq) + NaCl(aq) \rightarrow NaNO3(aq) + AgCl(s)$
- AgCl is a white precipitate

$C(s) + O2(g) \rightarrow CO2(g)$ (as when charcoal burns)
- $CO2$ is a gas
- the reaction is exothermic

Chemical reactions can be grouped into four basic types. They are direct combination or synthesis, decomposition, single replacement or substitution, and double replacement or exchange of ions.

Synthesis often results in the formation of only one product from two reactants, but not always. Combustion, as in the following example, $CH_4(g) + 2O_2\ (g) \rightarrow CO_2\ (g) + 2H_2O\ (aq)$, is also a form of synthesis because the oxygen combines with both the metal and the nonmetal to form two oxides.

Decomposition is the reverse of synthesis. One reactant breaks apart to form several products. This is what happens when hydrogen peroxide decomposes over time to leave behind plain, ordinary water [$2H_2O_2\ (aq) \rightarrow 2H_2O(g) + O_2\ (g)$].

During a **single replacement** reaction, a more active metal replaces a less active metal in a compound, or a more active nonmetal replaces a less active nonmetal in a compound. This is what happens when a metal becomes corroded by an acid [$2Fe(s) + 6HCl(aq) \rightarrow 2FeCl_3(aq) + 3H_2\ (g)$]. In single replacement reactions, an element is reacting with a compound.

Double replacement reactions occur between aqueous compounds. The cations and anions switch partners. If an insoluble precipitate forms, the reaction is an end reaction, otherwise the result is an aqueous mixture of ions. An example of a double replacement reaction is $AgNO_3(aq) + NaCl(aq) \rightarrow NaNO_3(aq) + AgCl(s)$.

Legend:
A and C = *metals*
B and D = *nonmetals*

Direct combination (synthesis)
A + B → AB *or* **AB + D → AD + BD**

Decomposition
AB → A + B

Single Replacement (substitution)
AB + C → CB + A *or* **AB + D → AD + B**

Double Replacement (Exchange of Ions)
AB + CD → AD + CB

For each of the following reactions, translate words into formulas and symbols. Be sure to include coefficients and physical states for *every* substance. THEN, write the equation and *illustrate* it using the Bingo chips. Use different colors to represent each element. Check your illustration for conservation of mass. Draw the particle diagram in the spaces below. Lastly, classify the type of reaction as *synthesis, decomposition, single replacement, or double replacement.*

Ex. **Two molecules of liquid water breakdown to make two molecules of hydrogen gas and one molecule oxygen gas. (Remember diatomic elements!)**

Formula Equation: $2\ H_2O_{(l)} \rightarrow 2\ H_{2\ (g)} + O_{2\ (g)}$

Drawing: °°Δ → °° + ΔΔ
°°Δ °°

Type of Reaction: Decomposition

1 Two moles of solid sodium and one molecule of chlorine gas combine to form two units of solid sodium chloride. (Remember diatomic elements!)

Formula Equation:

Drawing:

Type of reaction: _____

2 Two units of solid magnesium oxide decompose to form two moles magnesium and one molecule of oxygen gas.

Formula Equation:

Drawing:

Type of reaction: _____

For each of the following reactions, translate formulas and symbols into words. Be sure to account for coefficients and physical states. THEN, illustrate it using Bingo chips. Use different colors to represent each element. Check your illustrations for conservation of mass. Draw the particle diagram in the spaces below. Lastly, classify the type of reaction as synthesis, decomposition, single replacement, or double replacement.

Ex. $2\ H_{2\ (g)} + O_{2\ (g)} \rightarrow 2\ H_2O_{\ (l)}$

Word Equation: *Two molecules of hydrogen gas and one molecule oxygen gas make two molecules of liquid water.*

Drawing: °° + ΔΔ → °°Δ
°° °°Δ

Type of Reaction: Synthesis

3 $2KI(aq) + Br_2(l) \rightarrow 2KBr(aq) + I_2(s)$

Word Equation:

Drawing:

Type of reaction: _____

4 $3Zn(s) + 2FeCl_3(aq) \rightarrow 2Fe(s) + 3ZnCl_2(aq)$

Word Equation:

Drawing:

Type of reaction: _____

Practice: For each of the reactions described in questions 1-13, write the correct number to indicate whether the reaction type is (1) DECOMPOSITION, (2) DIRECT COMBINATION, (3) SINGLE REPLACEMENT, or (4) DOUBLE REPLACEMENT

1. $Pb(NO3)2(aq) + 2KI(aq) \rightarrow PbI2(s) + 2KNO3(aq)$ . . . . . _____
2. $Zn(s) + CuSO4(aq) \rightarrow ZnSO4(aq) + Cu(s)$ . . . . . _____
3. $FeCl3(aq) + 3NaOH(aq) \rightarrow Fe(OH)3(s) + 3NaCl(aq)$ . . . . _____
4. $2Mg(s) + O2(g) \rightarrow 2MgO(s)$ . . . . . _____
5. $H2CO3(aq) \rightarrow H2O(g) + CO2(g)$ . . . . . _____
6. $H2O(R) + N2O5(g) \rightarrow 2HNO3(aq)$ . . . . . _____
7. $Cl2(g) + 2NaBr(aq) \rightarrow 2NaCl(aq) + Br2(g)$ . . . . . _____
8. $2KClO3(s) \rightarrow 2KCl(s) + 3O2(g)$ . . . . . _____
9. $2K(s) + 2H2O(g) \rightarrow 2KOH(aq) + H2(g)$ . . . . . _____
10. A reaction occurs in which only one reactant is present..... _____
11. Metal reacts with an acid. ($2Fe + 6HCl \rightarrow 2FeCl3 + 3H2$).... _____

12. Two elements unite to form a compound..... _____

13. A compound breaks down..... _____

_____ 14. The fact that burning wood gives off heat is evidence of a (1) change in mass, (2) chemical change, (3) physical change, (4) phase change.

_____15. A reaction in which heat is given off is (1) exothermic, (2) endothermic, (3) caloric, (4) non caloric.

_____16. Which of the following is *NOT* evidence of a chemical change? (1) release of a gas (2) change in color (3) change in odor (4) change in shape

_____17. When silver nitrate solution is mixed with sodium chloride solution, a white solid forms immediately with no noticeable change in temperature. Which of the following is a true statement regarding the observed change. (1) The change is probably only physical because there is no change in temperature. (2) The change is probably only physical because no gas is released. (3) The change is probably chemical because a precipitate forms. (4) The change is probably chemical because the reaction is exothermic.

Name: _____

1) Which list includes three types of chemical reactions?
   A) decomposition, double replacement, and synthesis
   B) decomposition, solidification, and sublimation
   C) condensation, double replacement, and sublimation
   D) condensation, solidification, and synthesis

2) Given the balanced equation:

   $2KClO_3 \longrightarrow 2KCl + 3O_2$

   Which type of reaction is represented by this equation?
   A) decomposition
   B) double replacement
   C) synthesis
   D) single replacement

3) Given the reaction:

   $Mg(s) + 2AgNO_3(aq) \longrightarrow Mg(NO_3)_2(aq) + 2Ag(s)$

   Which type of reaction is represented?
   A) synthesis
   B) single replacement
   C) decomposition
   D) double replacement

4) Which equation represents a double replacement reaction?
   A) $CH_4 + 2O_2 \longrightarrow CO_2 + 2H_2O$
   B) $LiOH + HCl \longrightarrow LiCl + H_2O$
   C) $2Na + 2H_2O \longrightarrow 2NaOH + H_2$
   D) $CaCO_3 \longrightarrow CaO + CO_2$

5) Which equation shows a conservation of mass?
   A) $H_2O \longrightarrow H_2 + O_2$
   B) $Na + Cl_2 \longrightarrow NaCl$
   C) $PCl_5 \longrightarrow PCl_3 + Cl_2$
   D) $Al + Br_2 \longrightarrow AlBr_3$

6) If an equation is balanced properly, *both* sides of the equation must have the same number of
   A) molecules
   B) coefficients
   C) moles of molecules
   D) atoms

7) Given the unbalanced equation:

   $\_\_Al + \_\_CuSO_4 \longrightarrow \_\_Al_2(SO_4)_3 + \_\_Cu$

   When the equation is balanced using the *smallest* whole-number coefficients, what is the coefficient of Al?
   A) 1 B) 2 C) 3 D) 4