*Unit 8: Chemical Reactions and Equations*



*Important Vocabulary and formulas for Unit 8*

Chemical Reaction

Chemical Equation

Chemical Change

Physical Change

Reactant

Product

Coefficient

Subscript

Yield (→)

States of matter (g), (s), (l), (aq)

Aqueous (aq)

Precipitate (the noun)

Synthesis reaction (a.k.a addition, a.k.a. combination)

Decomposition reaction

Combustion reaction

Single replacement reaction

Double replacement reaction

Activity Series

Net ionic equation

Molecular Equation

Spectator Ions

Solubility

Solubility Rules

# *Notes: Balancing Equations*

According to the Law of Conservation of Mass, matter cannot be created or destroyed in a chemical reaction. It can only be changed from one form to another. This law applies to chemical reactions. The same number of atoms of each element that exist before the reaction will exist after the reaction. When we write the chemical equations for chemical reactions, the equations should be balanced. A balanced equation has the same number of atoms of each element on the left side of the yield sign (arrow) as on the right side of the yield sign.

Examine this equation: Mg + O2 → 2 MgO

On the left side of the equation, there is 1 atom of magnesium and 2 atoms of oxygen. On the right side there are 2 atoms of magnesium and 2 atoms of oxygen. The equation is not balanced. Coefficients can be used to balance this equation. When a 2 is placed in front of the Mg on the left side, the equation reads:

2 Mg + O2  → 2 MgO

Now there are 2 atoms of magnesium and 2 atoms of oxygen on the left side; ***the equation is balanced.***

Notice that oxygen is written as O2 on the left side of the equation and not simply O. This is because oxygen is diatomic. In the elemental state, it occurs as molecules of two oxygen atoms covalently bonded together. Magnesium is not diatomic, therefore it can be written alone. Always remember to write the diatomic elements in the correct manner. The diatomic elements are **H2,** **O2, N2, Cl2, Br2, I2, F2.**

Now examine this equation: P + O2 → P4O10

On the left side of the equation there is 1 atom of phosphorus and 2 atoms of oxygen. On the right side, there are 4 atoms of phosphorus and 10 atoms of oxygen. The equation is not balanced. By placing the coefficient 4 in front of the P on the left side, we get 4 atoms of phosphorus on each side. (**4** P + O2 → P4O10) However, the equation is still not balanced. By placing the coefficient 5 in front of the O2, we get 10 atoms of oxygen on each side of the equation. (4 P + **5** O2 → P4O10) Now the equation is balanced.

***First, look to see if there are any diatomic elements present. If so, write the subscript 2 in the correct place. Then write the coefficients in the blanks to balance the following chemical equations. Some blanks may be left empty.***

\_\_\_\_\_ F + \_\_\_\_\_ S → \_\_\_\_\_ SF6

 2. \_\_\_\_\_Zn + \_\_\_\_\_ O → \_\_\_\_\_ ZnO

 3. \_\_\_\_\_BaO2 → \_\_\_\_\_ BaO + \_\_\_\_\_ O

 4. \_\_\_\_\_ Na + \_\_\_\_\_ Cl → \_\_\_\_\_ NaCl

 5. \_\_\_\_\_P4 + \_\_\_\_\_ H → \_\_\_\_\_ PH3

 6. \_\_\_\_\_ Li + \_\_\_\_\_ O → \_\_\_\_\_Li2O

 7. \_\_\_\_\_ N + \_\_\_\_\_ H → \_\_\_\_\_ NH3

 8. \_\_\_\_\_ H2O2 → \_\_\_\_\_ H2O + \_\_\_\_\_ O

 9. \_\_\_\_\_ KClO3 → \_\_\_\_\_ KCl + \_\_\_\_\_ O

10. \_\_\_\_\_ Al + \_\_\_\_\_ O → \_\_\_\_\_Al2O3

## Helpful Info for Writing and Balancing Chemical Equations

CONSERVATION OF MASS AND ATOMS:

This idea is the key to the whole unit. When writing chemical equations just remember that any element that appears on the left side of the arrow must appear in equal number on the right side of the arrow.

BALANCING CHEMICAL EQUATIONS:

There are several rules you can use to make balancing equations a little bit easier and less frustrating.

Rules for Balancing Equations

 1. Determine the correct formulas for all the reactants and products in the reaction.

 2. Write formulas for the reactants on the left and the formulas for the products on the right with an arrow in between. If two or more reactants or products are involved, separate their formulas with plus signs. **Once the formulas are written, leave the subscripts alone.** You must never attempt to balance a chemical reaction by changing the subscripts in the chemical formula of a substance.

 3. Count the number of atoms of each element in the reactants and products. A polyatomic ion appearing unchanged on both sides of the equation is counted as a single unit. For example, if sulfate (SO4-2) appears on both sides of the arrow, balance SO4-2 all at once rather than balancing sulfur and oxygen separately.

 4. Balance the elements one at a time by using coefficients. A coefficient *is a small whole number that appears in front of a formula in an equation*. When no coefficient is written, it is assumed to be 1. It is best to begin with an element other than hydrogen or oxygen. These two elements often occur more than twice in an equation. Remember that you must never attempt to balance a chemical reaction by changing the subscripts in the chemical formula of a substance.

 To count the total number of atoms of any given element, multiply the coefficient by the subscript. Be sure to watch the case in which the element appears in more than one compound.

 5. Check each atom or polyatomic ion to be sure that the equation is balanced.

 6. Finally, make sure that all the coefficients are in the lowest possible ratio.

**Reaction Identification: There are 5 types of reactions we will study**

1. Synthesis (S) – Two or more reactants combine to form ***one product***.
2. Decomposition (D) – ***One reactant*** decomposes to form two or more products.
3. Single Replacement (SR) – An element and a compound form a new element and new compound.

A + BC → B + AC

1. Double Replacement (DR) – Two compounds form two new compounds.

AB + CD → AD + CB

1. Combustion (C) – A carbon containing compound ***reacts with oxygen*** to form CO2 and H2O.

# *Notes: Equations using Phase Notation*

In addition to identifying the substances present in a reaction, symbols can be used to give more information such as the state of a substance or the conditions of the reaction. The most commonly used symbols are given below:

 Symbol Explanation

 + Used to separate two reactants or products

* “Yields,” separates reactants from products

 = An alternative to → (not used in this class)

 ⇄ Used in place of a → for a reversible reaction

1. Designates a reactant or product in the solid state; placed after the formula
* Alternative to (s); USED ONLY FOR A SOLID PRODUCT (PRECIPITATE)
1. Designates a reactant or product in the liquid state; placed after the formula

 (aq) Designates an aqueous solution; the substance is dissolved in water

1. Designates a reactant or product in the gaseous state; placed after the formula
* Alternative to (g); USED ONLY FOR A GASEOUS PRODUCT

  Indicates that heat has been applied to the reaction.

  A formula written above or below the yield sign indicates its use as a catalyst (in

 this example, platinum).

 N.R. “No Reaction,” indicates that the given reactants do not react with each other.

Some useful hints:

* Only mercury and bromine occur in the elemental state as liquids.
* Only hydrogen, nitrogen, oxygen, fluorine, chlorine, and the noble gases occur in the elemental state as gases.
* Most acids are aqueous solutions. Assume they are aqueous unless specifically told otherwise.
* Some common gases that you should know as gases: carbon dioxide, carbon monoxide, ammonia, sulfur dioxide, sulfur trioxide
* Water normally occurs as a liquid unless specifically state otherwise (water vapor, steam, ice)
* Ionic compounds will be solid or in aqueous solution. Double replacement reactions usually take place with aqueous solutions. Single Replace, Synthesis or Decomposition reactions can take place in aqueous solutions or in the solid phase. Read the equation carefully – if an aqueous solution is used in a Single Replacement, Synthesis, or Decomposition reaction you will be given some sort of hint.

***Examples: Write and balance the following equations using all symbols.***

1. Magnesium metal reacts with nitrogen in the air to form magnesium nitride.
2. When aqueous solutions of silver nitrate and barium chloride are mixed, the products are aqueous barium nitrate and a precipitate of silver chloride.
3. When bromine reacts with solid calcium iodide, solid calcium bromide and iodine are produced.
4. Tin metal will react with solid copper (II) chloride to produce copper metal and solid tin (IV) chloride.
5. Zinc metal will react with hydrochloric acid to produce aqueous zinc chloride and hydrogen.

 6. Heating solid magnesium chlorate will produce oxygen and solid magnesium chloride.

*Notes: Recognizing Reaction Type*

The products of a chemical reaction may often be predicted by applying known facts about common reaction types. While there are hundreds of different kinds of reactions, only 5 general types will be considered in this class: synthesis, decomposition, single replacement, double replacement, and combustion. ***Don’t forget diatomics!!!***

A. A **SYNTHESIS** reaction occurs when two or more simple substances (elements or compounds) combined to form one new and more complex substance. The general form of a synthesis reaction is

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Element/compound | + | Element/compound | → | compound |
| A | + | B | → | AB |

 Example: 2Na + Cl2 → 2NaCl

B. A **DECOMPOSITION** reaction occurs when energy in the form of heat, light, electricity, or mechanical shock is supplied. A chemical catalyst may also be supplied. A compound may decompose to form simple compounds and/or elements. The general form of a decomposition reaction is

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Compound | → | Element/compound | + | Element/compound |
| AB | → | A | + | B |

 Note: It is possible to have more than 2 products, but there will only be one reactant.

 Example: 2Al2O3 → 4Al + 3O2

C. A **SINGLE REPLACEMENT** reaction occurs when one element displaces another element in a compound. The general form of a single replacement reaction is

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Element | + | Compound | → | Element | + | Compound |
| A | + | BC | → | B | + | AC |

D. A **DOUBLE REPLACEMENT** reaction when the positive and negative ions of the two reactants are interchanged. The general form of a double replacement reaction is

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Compound | + | Compound | → | Compound | + | Compound |
| AB | + | CD | → | AD | + | CB |

 Example: 2Al(NO3)3 + 3MgSO4 → Al2(SO4)3 + 3Mg(NO3)2

E. A **COMBUSTION** reaction occurs when oxygen reacts with a hydrocarbon to produce water, carbon dioxide, and usually heat and light. This is also called “burning”. The general form a combustion reaction is

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| Hydrocarbon | + | Oxygen | → | Carbon dioxide | + | Water |
| CxHy | + | O2 | → | CO2 | + | H2O |

 Example: 2C2H6 + 7O2 → 4CO2 + 6H2O

***More Examples: Classify each of the following reactions as synthesis, decomposition, single replacement, double replacement or combustion and balance them using all symbols.***

1. \_\_\_\_\_ H2 + \_\_\_\_\_ O2 → \_\_\_\_\_ H2O Type: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

2. \_\_\_\_\_Zn + \_\_\_\_\_ H2SO4 → \_\_\_\_\_ ZnSO4 + \_\_\_\_\_ H2 Type: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

3. \_\_\_\_\_NaNO3 → \_\_\_\_\_NaNO2 + \_\_\_\_\_ O2 Type: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

4. \_\_\_\_\_ Na2SO4 + \_\_\_\_\_BaCl2 → \_\_\_\_\_NaCl + \_\_\_\_\_BaSO4 Type: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

5. \_\_\_\_\_ C2H4 + \_\_\_\_\_ O2 → \_\_\_\_\_CO2 + \_\_\_\_\_ H2O Type: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

6. \_\_\_\_\_ KBr + \_\_\_\_\_ Cl2 → \_\_\_\_\_ KCl + \_\_\_\_\_ Br2 Type: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

7. \_\_\_\_\_ CaO + \_\_\_\_\_H2O → \_\_\_\_\_ Ca(OH)2 Type: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

8. \_\_\_\_\_ C4H10 + \_\_\_\_\_ O2 → \_\_\_\_\_ CO2 + \_\_\_\_\_ H2O Type: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

9. \_\_\_\_\_ Ca(NO3)2 + \_\_\_\_\_ K3PO4 → \_\_\_\_\_ Ca3(PO4)2 + \_\_\_\_\_ KNO3 Type: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

10. \_\_\_\_\_ HBr → \_\_\_\_\_ H2 + \_\_\_\_\_ Br2  Type: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

*Notes: Reaction Prediction*



In this unit we will learn to predict the products of reactions that can be classified as Decomposition, Synthesis, Single Replacement, Double Replacement, or Combustion. In order to predict the products of these reactions you must first identify the type of reaction you expect to take place. Then use the following notes along with the Reaction Reference sheet to predict the products. Once you have correctly written the formulas for both the reactants and products, you can then balance the reaction with the correct coefficients. Remember, DO NOT TRY TO PREDICT AND BALANCE AT THE SAME TIME. PREDICT THE PRODUCTS FIRST, THEN BALANCE!

**DECOMPOSITION:**

1. One reactant forms two or more products. General form: AB → A + B
2. This reaction occurs when energy in the form of heat, light, electricity, or mechanical shock is applied.
3. \*\*Different rules apply for different types of decomposition reactions:
4. Metal chlorates form metal chlorides plus oxygen: 2KClO3 → 2KCl + 3O2
5. Metal nitrates form metal nitrites plus oxygen: 2NaNO3 → 2NaNO2 + O2
6. Metal carbonates form metal oxides plus carbon dioxide: CaCO3 → CaO + CO2
7. Metal hydroxides form metal oxides plus water: Cu(OH)2 → CuO + H2O
8. Some acids decompose to form water plus a nonmetal oxide: H2CO3 → H2O + CO2
9. Ammonium compounds decompose to form ammonia (NH3) plus water: NH4OH → NH3 + H2O
10. Hydrated salts decompose to form the salt plus water: CuSO4 ­ ­ 5H2O → CuSO4 + 5H2O
11. Metal peroxides decompose to form metal oxides plus oxygen: 2H2O2 → 2H2O + O2

**SYNTHESIS**

1. Two reactants combine to form one product. General form: A + B → AB
2. When an element has more than one oxidation number (charge), the higher oxidation number is used for As, Sn, Fe, Hg, Cu, and Cr. (**As** **S**ta**n** **Fe**ll, **H**u**g**e **Cu**ps **Cr**acked). The smaller oxidation number is used for Co, Ni, Mn, Pb, Sb, and Bi.
3. \*\*Different rules apply for different types of synthesis reactions:
4. Metal oxides plus water form metal hydroxides: Na2O + H2O → 2NaOH
5. Nonmetal oxides plus water form acids: CO2 + H2O → H2CO3
6. Metal oxides plus nonmetal oxides form salts: CO2 + Na2O → Na2CO3

**SINGLE REPLACEMENT**

1. One active element takes the place of another less active element in a compound.
General form: A + BC → AC + B
2. The activity series is used to determine if a reaction will take place. One element can only replace a similar element if the element it is replacing is below it on the activity series.
3. REMEMBER; METALS REPLACE METALS; NONMETALS REPLACE NONMETALS!!!!
4. The very reactive members of Groups 1 & 2 (IA & 2A) react with water to produce hydrogen and the metal hydroxide (Li, Na, K, Rb, Cs, Ca, Sr, Ba). 2Na + 2H2O → 2NaOH + H2
5. When an element has more than one oxidation number (charge), the higher oxidation number is used for As, Sn, Fe, Hg, Cu, and Cr. (**As** **S**ta**n** **Fe**ll, **H**u**g**e **Cu**ps **Cr**acked). The smaller oxidation number is used for Co, Ni, Mn, Pb, Sb, and Bi. Example: 2Fe + 3CuSO4 → Fe2(SO4)3 + 3Cu

**DOUBLE REPLACEMENT**

1. The positive ions in two compounds switch places. Each compound formed always consists of a (+) and a (-) ion. General Form: AB + CD → AD + CB
2. \*\*An acid plus a carbonate forms a salt plus water plus carbon dioxide. 2HCl + Na2CO3 → 2NaCl + H2O + CO2
3. A neutralization reaction is a special type of double replacement reaction:
HCl + KOH → KCl + H2O (acid + base → salt + water)

**COMBUSTION**

1. A substance reacts with oxygen often producing energy in the form of heat an light (also called “burning”).
2. Commonly involves hydrocarbons (compounds containing carbon and hydrogen). In this case, the products will always be carbon dioxide and water. General form: CxHy + O2 → CO2 + H2O
3. The coefficients in these reactions can be larger than in other types of reactions.

*Notes: Net Ionic Equations*

Net ionic equations show only those ions and pure substances that are involved in a double or single replacement reaction. Some substances should be shown as aqueous ions and others will need to be shown as molecules. See Part II below to determine which substances should be shown as ions and which should be shown as molecules. Spectator ions are ions that are present but do not participate in the reaction. Their purpose is to maintain electrical neutrality in the reaction. The spectator ions are identified by the fact that they do not change during the reaction and remain in solution. Molecular equations show every species present in the reaction whether it participates or not. Net ionic equations show only the species that participate in the reaction. Below are some examples of molecular equations and their net ionic equations.

Ex. 1. Molecular Equation Net Ionic Equation

 Na2SO4(aq) + BaCl2(aq) → 2NaCl(aq) + BaSO4(s) Ba+2(aq) + SO4-2(aq) → BaSO4(s)

Ex. 2. Molecular Equation Net Ionic Equation

 HCl(aq) + NaOH(aq) → NaCl(aq) + H2O(l) H+1(aq) + OH-1(aq) → H2O(l)

1. How to determine which substances should be shown as ions and which should be shown as molecules.
2. What to write as aqueous ions (ion symbol – with charge – followed by (aq) )
3. Soluble salts (ionic compounds) – look at your solubility table to determine if a compound is soluble. Examples: NaCl(aq), KNO3(aq), MgSO4(aq)
4. Strong Acids – acids that completely dissociate in water (HCl, HBr, HI, H2SO4, HNO3, HClO4, HClO3)
5. What to write in molecular form (molecular formula followed by (s), (l), or (g) )
6. Insoluble salts – look at your solubility table to determine if a salt is not soluble. Examples: AgCl(s), BaSO4(s), MgCO3(s)
7. Gases – including Noble Gases, diatomic elements, and certain molecular compounds that are gases Examples: H2(g), O2(g), He(g), Kr(g), CO2(g), NH3(g)
8. WATER!!!! H2O(l)
9. When writing a Net Ionic Equation, the state of the reactant and products MUST be shown!!

1. solid – (s) 2. Liquid – (l) 3. Gas – (g) 4. Aqueous – (aq)

Steps in Writing Net Ionic Equations

1. Write and balance the complete molecular equation.
2. Determine which of the reactants and products should be written in ionic (aq) or molecular (s, l, g) form.
3. Write the COMPLETE IONIC EQUATION (everything that dissociates into ions is written as ions.)
4. Cancel out spectator ions (anything that’s EXACTLY the same on both sides of the complete ionic eqn.)
5. Write out the NET IONIC EQUATION. Make sure that it is balanced.
6. Types of reactions to expect:
7. Single replacement reactions – both cation and anion replacement
8. Double replacement reactions – one of three things will happen.
	1. A precipitate (a solid product) will form
	2. An acid and base will react to form water.
	3. No reaction will occur (all species are soluble!)

**Example 1: Nitric Acid + Barium hydroxide**

1. Balanced Molecular Equation (don’t forget states)
2. Complete Ionic Equation
3. Net Ionic Equation

**Example 2: Copper + Silver Nitrate**

1. Balanced Molecular Equation
2. Complete Ionic Equation
3. Net Ionic Equation

**Example 3: Barium Chloride + Sodium Sulfate**

1. Balanced Molecular Equation
2. Complete Ionic Equation
3. Net Ionic Equation

**Example 4: Sodium Chloride + Ammonium Sulfate**

1. Balanced Molecular Equation
2. Complete Ionic Equation

C. Net Ionic Equation

*Homework #1: Writing and Balancing Equations*

* Identify each equation according to one of the five types. Use the correct abbreviation and write it in the blank provided.
* Write the correct formulas for each of the following substances then balance the equations by adjusting the coefficients.
* DON’T FORGET ABOUT DIATOMIC ELEMENTS (HONClBrIF) !!!!!
1. Sodium (Na) + chlorine (Cl2) → sodium chloride (NaCl)
2. carbon (C) + oxygen (O2) → carbon dioxide (CO2)
3. water (H2O) → hydrogen (H2) + oxygen (O2)
4. magnesium + oxygen → magnesium oxide
5. magnesium + hydrogen chloride → magnesium chloride + hydrogen
6. potassium + hydrochloric acid → potassium chloride + hydrogen
7. sodium bromide + silver nitrate → sodium nitrate + silver bromide
8. aluminum + hydrochloric acid → aluminum chloride + hydrogen
9. barium chloride + sodium phosphate → barium phosphate + sodium chloride
10. aluminum + iron (III) oxide → aluminum oxide + iron.
11. lithium + chlorine → lithium chloride

1. potassium + sulfur → potassium sulfide
2. iron + copper (I) nitrate → iron (II) nitrate + copper
3. zinc + sulfuric acid → zinc sulfate + hydrogen
4. calcium + fluorine → calcium fluoride
5. barium + iodine → barium iodide
6. lithium bromide→ lithium + bromine
7. sodium chloride + sulfuric acid → sodium sulfate + hydrochloric acid
8. aluminum + oxygen → aluminum oxide
9. aluminum oxide → aluminum + oxygen
10. magnesium nitrate + calcium iodide → calcium nitrate + magnesium iodide
11. iron (III) oxide + carbon → iron + carbon monoxide
12. potassium iodide + lead (II) nitrate → lead (II) iodide + potassium nitrate
13. iron (II) sulfide + hydrochloric acid → hydrosulfuric acid + iron (II) chloride
14. mercury (II) hydroxide + phosphoric acid (H3PO4) → mercury (II) phosphate + water
15. sodium peroxide (Na2O2) + water → sodium hydroxide + oxygen
16. calcium carbonate → calcium oxide + carbon dioxide
17. calcium chloride + nitric acid → calcium nitrate + hydrochloric acid
18. ammonia (NH3) + oxygen → nitrogen + water
19. fluorine + sodium hydroxide → sodium fluoride + oxygen + water
20. sodium nitrate → sodium nitrite + oxygen
21. magnesium bicarbonate + hydrochloric acid → magnesium chloride + water + carbon dioxide
22. silicon + water → silicon dioxide + hydrogen
23. zinc sulfide + oxygen → zinc oxide + sulfur dioxide
24. ammonium dichromate → chromium (III) oxide + nitrogen + water
25. arsenic + oxygen → diarsenic trioxide

*Homework #2: Equations Using Phase Notation*

1. When solid calcium carbonate is heated, solid calcium oxide and carbon dioxide are produced.

2. Aluminum metal reacts with oxygen in the air to form aluminum oxide.

3. When solid mercury (II) sulfide is heated with oxygen, mercury metal and gaseous sulfur dioxide are produced.

4. Oxygen gas can be made by heating solid potassium chlorate in the presence of the catalyst manganese (IV) oxide. Potassium chloride is left as the solid residue.

5. Solid sodium bicarbonate reacts with hydrochloric acid to produce aqueous sodium chloride, water, and carbon dioxide.

6. When aqueous solutions of barium chloride and sulfuric acid are mixed, hydrochloric acid and a precipitate of barium sulfate are produced.

7. Ammonia (NH3) and oxygen react in the presence of a platinum catalyst to produce nitrogen monoxide gas and water vapor.

8. Dinitrogen trioxide gas reacts with water to produce nitrous acid.

9. Hydrogen and aqueous iron (III) chloride are produced when metallic iron is dropped into hydrochloric acid.

10. Mercury metal is produced by heating a mixture of solid mercury (II) sulfide and calcium oxide. Calcium sulfide and calcium sulfate are also produced.

11. Silver oxide is heated to produce silver metal and oxygen.

12. Solid tetraphosphorus decoxide reacts with water to produce phosphoric acid.

13. Bubbling chlorine through an aqueous solution of potassium iodide gives elemental iodine and an aqueous solution of potassium chloride.

14. Heating sulfuric acid produces water vapor, oxygen, and sulfur dioxide gas.

15. When solid ammonium carbonate is heated it decomposes to form ammonia gas (NH3), carbon dioxide, and water vapor.

# *Homework #3: More Balancing and Reaction Identification*

Identify the reactions below as Synthesis (S), Decomposition (D), Single Replacement (SR), Double Replacement (DR), or Combustion (C). Correctly write the formulas for the compounds and elements, then balance the equation using all symbols.

1. Aluminum hydroxide + nitric acid → aluminum nitrate + water \_\_\_\_\_\_\_\_\_\_

2. Sodium peroxide → sodium oxide + oxygen \_\_\_\_\_\_\_\_\_\_

3. Barium chloride + potassium carbonate → barium carbonate + potassium chloride \_\_\_\_\_\_\_\_\_\_

4. Sodium sulfide → sodium + sulfur \_\_\_\_\_\_\_\_\_\_

5. Silver + oxygen → silver oxide \_\_\_\_\_\_\_\_\_\_

6. Pentene (C5H10) + oxygen → carbon dioxide + water \_\_\_\_\_\_\_\_\_\_

7. Aluminum + copper (II) sulfate → copper + aluminum sulfate \_\_\_\_\_\_\_\_\_\_

8. Sodium + water → sodium hydroxide + hydrogen \_\_\_\_\_\_\_\_\_\_

9. Iron (III) hydroxide → iron (III) oxide + water \_\_\_\_\_\_\_\_\_\_

10. Calcium + nitrogen → calcium nitride \_\_\_\_\_\_\_\_\_\_

11. Chromium (III) nitrate + potassium sulfate → chromium (III) sulfate + potassium nitrate \_\_\_\_\_\_\_\_\_\_

12. Zinc chloride + ammonium sulfide → ammonium chloride + zinc sulfide \_\_\_\_\_\_\_\_\_\_

13. Butane (C4H10) + oxygen → carbon dioxide + water \_\_\_\_\_\_\_\_\_\_

14. Sodium iodide + bromine → sodium bromide + iodine \_\_\_\_\_\_\_\_\_\_

15. Hydrochloric acid + zinc → zinc chloride + hydrogen \_\_\_\_\_\_\_\_\_\_

16. Sodium + oxygen → sodium oxide \_\_\_\_\_\_\_\_\_\_

17. Strontium nitrate → strontium nitrite + oxygen \_\_\_\_\_\_\_\_\_\_

18. Hydrosulfuric acid + lead (II) acetate → lead (II) sulfide + acetic acid \_\_\_\_\_\_\_\_\_\_

19. Hydrogen + fluorine → hydrofluoric acid \_\_\_\_\_\_\_\_\_\_

20. Magnesium oxide + carbon dioxide → magnesium carbonate \_\_\_\_\_\_\_\_\_\_

21. Barium nitride → barium + nitrogen \_\_\_\_\_\_\_\_\_\_

22. Sulfur + oxygen → sulfur trioxide \_\_\_\_\_\_\_\_\_\_

23. Potassium + silver chloride → potassium chloride + silver \_\_\_\_\_\_\_\_\_\_

24. Sulfur trioxide + water → sulfuric acid \_\_\_\_\_\_\_\_\_\_

25. Benzene (C6H6) + oxygen → carbon dioxide + water \_\_\_\_\_\_\_\_\_\_

26. Calcium + water → calcium hydroxide + hydrogen \_\_\_\_\_\_\_\_\_\_

27. Sulfurous acid → sulfur dioxide + water \_\_\_\_\_\_\_\_\_\_

28. Mercury + iodine → mercury (II) iodide \_\_\_\_\_\_\_\_\_\_

29. Lithium oxide + water → lithium hydroxide \_\_\_\_\_\_\_\_\_\_

*Homework #4: Reaction Prediction*

* ***State what type of reaction is expected (D, S, SR, DR, C)***
* ***Predict the products and complete the word equation.***
* ***Write the balanced equation for those reactions that take place.***
* ***Include the states of matter for each species for DR and SR***
	+ ***DR start with two aqueous, SR starts with one aqueous and one elemental***

***EXAMPLES: State what type of reaction is expected (D, S, SR, DR, C) in the blank.***

 ***Predict the product(s) and complete the word equation.***

 ***Write balanced equation for the reactions that do take place.***

\_\_\_\_\_ 1. Calcium + magnesium oxide →

\_\_\_\_\_ 2. Copper (II) hydroxide →

\_\_\_\_\_ 3. Zinc plus oxygen →

\_\_\_\_\_ 4. Aluminum phosphate + nickel (II) sulfide →

\_\_\_\_\_ 5. Sodium nitrate + hydrogen →

\_\_\_\_\_ 6. Propane (C3H8) + oxygen →

\_\_\_\_\_ 1. Aluminum sulfate + calcium phosphate →

\_\_\_\_\_ 2. Zinc metal + copper (II) nitrate →

\_\_\_\_\_ 3. Sodium chlorate →

\_\_\_\_\_ 4. Mercury (II) oxide + water →

\_\_\_\_\_ 5. Ammonia gas (NH3) + hydrochloric acid → ***(Hint: Single product!)***

\_\_\_\_\_ 6. Hydrofluoric acid + magnesium carbonate →

\_\_\_\_\_ 7. Calcium nitrate →

\_\_\_\_\_ 8. Aluminum metal + hydrochloric acid →

\_\_\_\_\_ 9. Calcium carbonate →

\_\_\_\_\_ 10. Iron metal + copper (II) sulfate →

\_\_\_\_\_ 11. Hexane (C6H14) + oxygen →

\_\_\_\_\_ 12. Cadmium hydroxide →

\_\_\_\_\_ 13. Tin + chlorine →

\_\_\_\_\_ 14. Carbonic acid + lithium hydroxide →

\_\_\_\_\_ 15, Bromine + zinc chloride →

\_\_\_\_\_ 16. Sulfurous acid →

\_\_\_\_\_ 17. Sulfur trioxide + water →

\_\_\_\_\_ 18. Decane (C10H22) + oxygen →

\_\_\_\_\_ 19. Silver + potassium chloride →

\_\_\_\_\_ 20. Barium + sulfur →

\_\_\_\_\_ 21. Silver nitrate + zinc chloride →

\_\_\_\_\_ 22. Sulfuric acid + sodium hydroxide →

*Homework #5: More Reaction Prediction*

* ***State what type of reaction is expected (D, S, SR, DR, C)***
* ***Predict the products and complete the word equation.***
* ***Write the balanced equation for those reactions that take place.***

\_\_\_\_\_\_\_ 1. Ammonium acetate + iron (II) chloride →

\_\_\_\_\_\_\_ 2. Iodine + ammonium fluoride →

\_\_\_\_\_\_\_ 3. Potassium nitrate (heated) →

\_\_\_\_\_\_\_ 4. Barium oxide + water →

\_\_\_\_\_\_\_ 5. Calcium + aluminum chloride →

\_\_\_\_\_\_\_ 6. Calcium hydroxide (heated) →

\_\_\_\_\_\_\_ 7. Methane (CH4) plus oxygen →

\_\_\_\_\_\_\_ 8. Sodium chloride + potassium chromate →

\_\_\_\_\_\_\_ 9. Water (electrolyzed) →

\_\_\_\_\_\_\_ 10. Lithium hydroxide + phosphoric acid →

\_\_\_\_\_\_\_ 11. Iron + potassium iodide →

\_\_\_\_\_\_\_ 12. Mercury (II) sulfate + ammonium nitrate →

\_\_\_\_\_\_\_ 13. Bromine + sodium chloride →

\_\_\_\_\_\_\_ 14. Silver sulfide + hydrochloric acid →

\_\_\_\_\_\_\_ 15. Aluminum chloride (electrolyzed) →

\_\_\_\_\_\_\_ 16. Iron + sulfur →

\_\_\_\_\_\_\_17. Iron (III) hydroxide + nitric acid →

\_\_\_\_\_\_\_ 18. Lead + tin (II) nitrate →

\_\_\_\_\_\_\_ 19. Calcium + phosphoric acid →

\_\_\_\_\_\_\_ 20. Sulfur dioxide + water →

\_\_\_\_\_\_\_ 21. Hexane (C6H14) + oxygen →

\_\_\_\_\_\_\_ 22. Chlorine + lithium bromide →

\_\_\_\_\_\_\_ 23. Strontium hydroxide (heated) →

\_\_\_\_\_\_\_ 24. Zinc chlorate (heated) →

\_\_\_\_\_\_\_ 25. Magnesium + hydrochloric acid →

\_\_\_\_\_\_\_ 26. Zinc + sulfur →

\_\_\_\_\_\_\_ 27. Aluminum sulfate + barium chloride →

\_\_\_\_\_\_\_ 28. Magnesium hydroxide + sulfuric acid →

\_\_\_\_\_\_\_ 29. Barium hydroxide + nitric acid →

\_\_\_\_\_\_\_ 30. Aluminum + bromine →

\_\_\_\_\_\_\_ 31. Aluminum + hydrochloric acid →

\_\_\_\_\_\_\_ 32. Chlorine + aluminum iodide →

\_\_\_\_\_\_\_ 33. Zinc + tin (IV) nitrate →

\_\_\_\_\_\_\_ 34. Potassium bromide + lead (II) nitrate →

\_\_\_\_\_\_\_ 35. Calcium + iodine →

*Homework #6: Net Ionic Equations*

***For each of the following: A. Write a balanced molecular equation (including states)***

***B. Write the complete ionic equation (including states)***

***C. Write the net ionic equation (including states)***

***D. All compounds are aqueous and all elements are in their natural state***

1. potassium chloride + lead (II) nitrate →

a.

b.

c.

1. calcium chloride + sodium carbonate →

a.

b.

c.

1. iron (III) sulfate + lithium carbonate →

a.

b.

c.

1. iron (III) chloride + sodium sulfide →

a.

b.

c.

1. ammonium phosphate + magnesium nitrate →

a.

b.

c.

1. potassium hydroxide + sulfuric acid →

a.

b.

c.

1. aluminum + lead (II) acetate →

a.

b.

c.

1. bromine + sodium iodide →

a.

b.

c.

1. hydrobromic acid + sodium hydroxide →

a.

b.

c.

1. potassium acetate + silver nitrate →

a.

b.

c.

1. Strontium nitrate + barium hydroxide →

a.

b.

c.

1. Ammonium carbonate + magnesium sulfate →

a.

b.

c.

1. calcium nitrate + magnesium sulfate →

a.

b.

c.

1. Fluorine + potassium sulfide →

a.

b.

c.

1. Silver nitrate + chromium (III) chloride →

a.

b.

c.

1. Calcium hydroxide + phosphoric acid →

a.

b.

c.

1. Potassium phosphate + lithium iodide →

a.

b.

c.

1. Zinc + copper (II) nitrate →

a.

b.

c.

1. Calcium iodide + magnesium sulfate →

a.

b.

c.

1. Lithium hydroxide + sulfuric acid →

a.

b.

c.

*Review Unit 8*

1. Metal hydroxides decompose when heated to yield metal oxides and

 a. metal hydrides. b. water. c. carbon dioxide. d. an acid.

2. The reaction of calcium oxide with water will yield

 a. calcium and oxygen. b. calcium hydroxide. c. calcium and a salt. d. carbon dioxide and water.

3. Of the following equations, the one that is correctly balanced is

 a. HgO → Hg + O2 b. 2C + O2 → 2CO c. 2Zn + Cl2 → 2ZnCl2 d.2H2O → H2 + O2

4. How would oxygen be represented in the formula equation for the reaction of methane (CH4) and oxygen to yield carbon dioxide and water?

 a. oxygen b. O c. O2 d. O3

5. Since mercury is below copper in the activity series, heating HgO will result in (hint who cares about copper)

 a. no reaction. b. the formation of a hydroxide.

 c. the formation of HgO. d. decomposition.

6. Once the correct formula for a reactant in an equation has been written, the

1. subscripts are adjusted to balance the equation.
2. formula should not be changed.
3. same formula must appear as a product.
4. symbols used in the formula must not be used on the product side of the equation.

7. A small whole number that appears In front of a formula in a chemical equation is called a

 a. subscript. B. superscript. C. ratio. D. coefficient.

8. Metals oxides such as CaO react with water to produce

 a. metal carbonates. b. metal hydrides. c. acids. d. metal hydroxides.

9. The equation Mg + 2HCt --H2 + MgCI2 is an example of a

 a. synthesis reaction. b. single replacement reaction.

 c. decomposition reaction. d. double replacement reaction e combustion reaction.

10. A reaction in which the ions of two compounds exchange places to form two new compounds is called a(n)

 a. synthesis reaction. b. single replacement reaction.

 c. decomposition reaction. d. double replacement reaction e combustion reaction.

11. Magnesium bromide + chlorine yield

 a. Mg and BrCl. B. MgCl + Br2. c. MgBrCl. d. MgCl2 + Br2.

12. Magnesium hydroxide will decompose to yield magnesium oxide and

 a. hydrogen. B. oxygen. c. water. d. salt.

13. In a chemical equation "🡪" is read

 a. aqueous. b. moves. c. yields. d. points.

14. The equation A + X 🡪 AX is the general equation for a(n)

 a. synthesis reaction. b. single replacement reaction. c. decomposition reaction.

 d. double replacement reaction. e. combustion reaction .

15. 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.

16. The decomposition of a binary compound results in the production of

 a. an oxide. b. an acid. c. a ternary compound. d. two elements.

17. Which of the following is one of the products when hydrochloric acid reacts with sodium hydroxide?

 a. sodium hydride b. potassium chloride c. water d. hydrogen gas

18. The equation 2KCIO3 → 2KCI + 3O2 is an example of a

 a. synthesis reaction. b. single replacement reaction. c. decomposition reaction.

 d. double replacement reaction. e. combustion reaction.

19. 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

20. A reaction that should not occur is

 a. 2HF + Cl2 → F2 + 2HCl. b. 2Na + ZnF2 → 2NaF + Zn.

 c. Fe + CuCl2 → FeCl2 + Cu d. 2HCl + Mg → MgCl2 + H2

21. 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

22. The equation A + BX 🡪 AX + B is the general equation for a

 a. synthesis reaction. b. single replacement reaction. c. decomposition reaction

 d. double replacement reaction e. combustion reaction

23. To balance a chemical equation it is permissible to adjust the

 a. coefficients. b. subscripts. c. formulas of products. d. number of products.

24. A reaction in which one element replaces a similar element in a compound is called a(n)

 a. synthesis reaction. b. single replacement reaction. c. decomposition reaction.

 d. double replacement reaction. e. combustion reaction.

25. The general equation for double replacement reactions is

 a. A + X 🡪 AX. b. A + BX 🡪 AX + B. c. Y + BX 🡪 BY + X. d. AX + BY 🡪 AY + BX.

26. A reaction in which a single compound produces two or more simple substances is called a(n)

 a. synthesis reaction. b. single replacement reaction. c. decomposition reaction.

 d. double replacement reaction. e. combustion reaction.

27. After writing the formula for the products and reactants in an equation, the equation is balanced by

 a. adjusting subscripts to the formula(s). b. adjusting coefficients to the smallest whole number ratio.

 c. changing the products formed. d. having the number of reactants equal number of products.

28. When the equation Fe3O4 + Al → Al2O3 + Fe is correctly balanced, the coefficient of Fe is

 a. 3. b. 4. c. 6. d. 9.

29. What product or product will result from the decomposition of HgO?

 a. mercury (I) oxide b. mercury and oxygen c. mercury hydroxide d. only mercury

30. Predict what will happen when nickel is added to a solution of potassium chloride.

 a. No reaction will occur b. Nickel chloride will form

 c. Potassium nickel chloride will form d. Hydrochloric acid will form.

31. A reaction which can be predicted from the activity series is

 a. 2Cl → Cl2. b. HCl + NaOH → H2O + NaCl.

 c. 2HCl + 2Na → 2NaCl + H2. d. Cl2 → 2Cl.

32. The equation HCl + NaOH → NaCl + H2O is an example of a

 a. synthesis reaction. b. single replacement reaction. c. decomposition reaction.

 d. double replacement reaction. e. combustion reaction.

33. When heated, a metal carbonate decomposes into a metal oxide and

 a. carbon. b. carbon dioxide. c. oxygen. d. hydrogen.

34. The equation of Cl2 + 2KBr → 2KCl + Br2 is an example of a

 a. synthesis reaction. b. single replacement reaction. c. decomposition reaction.

 d. double replacement reaction. e. combustion reaction.

35. The balanced equation for the reaction that occurs when barium carbonate is heated is

 a. 2BaCO3 → 2Ba + 2CO2 + O2. b. Ba(CO3)2 → BaO2 + 2CO2.

 c. BaCO3 → BaO + CO2 . d. BaCO3 → Ba + C + O3.

36 The balanced equation that takes place when sulfur burns in air is

 a. S + O2 → SO. b. S + O2 → SO2. c. 2S + 3O2 → SO3. d. S + 2O2 →SO4-2.

37 The reaction 2Mg + O2 → 2MgO is an example of a

 a. synthesis reaction. b. single replacement reaction. c. decomposition reaction.

 d. double replacement reaction. e. combustion reaction.

38. Which of the following is equation for the complete combustion of propane, C3H8?

 a. C3H8 + 6H2O → 3CO2 + 10H2O b. C3H8 → 3C + 4H2

 c. 2C3H8 + 9O2 → 6H2CO3 + 2H2 d. C3H8 + 5O2 → 3CO2 + 4H2O

39. Which of the following alternative below is the balanced equation for the reaction between gallium chloride and fluorine gas?

 a. 2GaCl3 + (F2)3 → 2GaF3 + (Cl2)3. b. 2GaCl3 + 3F2 → 2GaF3 + 3Cl2.

 c. Ga(Cl3)2 + 3F2 → Ga(F3)2 + 3Cl2. d. 3GaCl3 + 2F2 → 3GaF3 + 2Cl2.

40. What is the identifying characteristic of synthesis reaction?

 a. a single reactant b. a reaction between two ionic compounds

 c. a single product d. a reaction between an element and a compound

41. What is the identifying characteristic of a decomposition reaction?

 a. a single reactant b. a reaction between two ionic compounds

 c. a single product d. a reaction between an element and a compound

42. What is the identifying characteristic of a single replacement reaction?

 a. a single reactant b. a reaction between two ionic compounds

 c. a single product d. a reaction between an element and a compound

43. What is the identifying characteristic of a double replacement reaction?

 a. a single reactant b. a reaction between two ionic compounds

 c. a single product d. a reaction between an element and a compound

44. What is the balanced equation that describes the reaction between magnesium carbonate and nitric acid?

 a. MgCO3 + HNO3 → Mg(NO3)2 + CO2 + H2O b. MgCO3 + 2HNO3 → Mg(NO3)2 + CO2 + H2O

 c. MgCO3 + 2HNO3 → Mg(NO3)2 + CO2 + H2 d. MgCO3 + HNO3 → Mg(NO3)2 + CO2

45. When the reaction between calcium oxide and water is complete and balanced, what is the product (including its coefficients)?

 a. Ca(OH)2 b. CaH2 c. Ca(OH)3 d. 2CaOH

46. What type of reaction does the following equation describe? 2C5H10 + 15O2 → 10 CO2 + 10H2O

 a. synthesis reaction. b. single replacement reaction. c. decomposition reaction.

 d. double replacement reaction. e. combustion reaction.

47. According to the law of conservation of mass, the total mass of the reacting substances is

1. always more than the total mass of the products.
2. always less than the total mass of the products.
3. sometimes more and sometimes less than the total mass of the products.
4. always equal to the total mass of the products.

48. An equation is NOT balanced unless

 a. it shows atoms being conserved. b. the reaction has been carried out in a laboratory.

 c. all chemicals have coefficients greater than 1. d. there are the same number of reactants and products.

49. When the equation Al2(SO4)3 + Ca(OH)2 → CaSO4 + Al(OH)3 is correctly balanced, the coefficient in front of the Ca(OH)2 is

 a. 1 b. 2 c. 3 d. 4

50. Predict the product of MgO + CO2 →

 a. MgCO3 b. Mg + CO3 c. MgC + O3 d. MgCO2 + O

51. The set of coefficients that will correctly balance the equation CaO + H2O → Ca(OH)2 is

 a. 2, 1, 2. b. 1, 2, 3. c. 1, 2, 1. d. 1, 1, 1.

52. The set of coefficients that will correctly balance the equation NH4NO2 → N2 + H2O is

 a. 1, 2, 2. b. 1, 1, 2. c. 2, 1, 1. d. 2, 2, 2.

53. The set of coefficients that will correctly balance the equation AgNO3 + CuCl2 🡪 AgCl + Cu(NO3)2 is

 a. 1, 1, 1, 1. b. 2, 1, 2, 1. c. 1, 2, 1, 2. d. 1, 2, 2, 1.

54. The equation Ax 🡪 A + X is the general equation for a

 a. synthesis reaction. b. single replacement reaction. c. decomposition reaction.

 d. double replacement reaction. e. combu5tlon reaction.