Name _____ Period _____

Writing and Balancing Chemical Equations

When a substance undergoes a chemical reaction, chemical bonds are broken and new bonds are formed. This results in one or more new substances, often with entirely different properties. The "ingredients" or starting materials in a chemical reaction are referred to as **reactants** and the substances produced in the reaction are called **products.** A chemical *equation* is a chemist's method of showing the changes in the arrangement of atoms that occur during a chemical reaction.

How to Write and Balance a Chemical Equation:

1. Identify the reactants and products of the reaction. Reactants will appear on the left and products will appear on the right.

2. Write the correct formula for each of the reactants and products. If a reactant or product is a gas, it should be followed by the symbol (**g**). Similarly, solids should be followed by (**s**), and liquids by (**l**). If a substance is dissolved in water, it should be followed by the symbol **(aq)**, which is short for the Latin word ***aqueous***.

   Note: Some elements exist as *molecules* rather than just atoms. You are responsible for memorizing the 7 "diatomic" elements: H_2, N_2, O_2, F_2, Cl_2, Br_2, I_2. The diatomic elements are only diatomic when they are ALONE (not part of a compound).

3. Balance each equation using coefficients that appear in front of each reactant or product. **You may not change the subscripts in a formula in order to balance an equation.** These subscripts define the compounds. You may only use coefficients!

4. There is no single method for balancing a chemical equation, but here is a suggested strategy:
   - First, balance metal atoms or atoms that occur only once on the reactant side and once on the product side.
   - Next, balance everything *except* hydrogen and oxygen.
   - Next, balance the hydrogens.
   - Finally, balance the oxygens.
   - Other tips:
     - Balance polyatomic ions as polyatomic ions, not as individual atoms, where possible. (For example: if "sulfate" appears on both sides of an equation, count each "SO_4^{2-}" as one sulfate, rather than one sulfur and four oxygens.
     - If you have an odd number of atoms on one side of an equation and an even number on the other side of the equation, make the odd number even by doubling the coefficient. Then, go back and balance everything else.

5. Check to see that every atom that appears on the left side of the equation also appears on the right side. **Remember: the law of conservation states that that the same number of each atom must appear on both sides of the equation.**

Example:

Carbon + Oxygen → Carbon Monoxide
Write the formulas for the species: **___C(s) + ___O_2(g) → ___CO(g)**
Use coefficients to balance the equation: **2** C(s) + O_2(g) → **2** CO(g)
Check to see that it is balanced: there are 2 carbons and 2 oxygens on each side

Balancing Chemical Equations – Worksheet #1

Balance the following chemical equations:

1. _____$Al\ (s)$ + _____$HCl\ (aq)$ → _____$AlCl_3\ (aq)$ + _____$H_2\ (g)$

2. _____$K\ (s)$ + _____$H_2O\ (l)$ → _____$KOH\ (aq)$ + _____$H_2\ (g)$

3. _____$Mg\ (s)$ + _____$N_2\ (g)$ → _____$Mg_3N_2\ (s)$

4. _____$NaNO_3\ (s)$ → _____$NaNO_2\ (s)$ + _____$O_2\ (g)$

5. ____$Ca(OH)_2\ (s)$ + ____$H_3PO_4\ (aq)$ → ___$Ca_3(PO_4)_2\ (s)$ + ___$H_2O\ (l)$

6. _____$C_3H_8\ (g)$ + _____$O_2\ (g)$ → _____$CO_2\ (g)$ + _____H_2O (g

7. _____$NH_3\ (g)$ + _____$O_2\ (g)$ → _____$NO\ (g)$ + _____$H_2\ (g)$

8. _____$N_2\ (g)$ + _____$H_2\ (g)$ → _____$NH_3\ (g)$

9. ___$Na_2CO_3\ (s)$ + ___$HCl\ (aq)$ → ___$NaCl\ (aq)$ + __$CO_2\ (g)$ + __$H_2O\ (l)$

10. _____$C_3H_5OH\ (l)$ + _____$O_2\ (g)$ → _____$CO_2\ (g)$ + _____$H_2O\ (g)$

11. ___$NH_3\ (g)$ + ___$CuO\ (s)$ → ___$N_2\ (g)$ + ___$Cu\ (s)$ + ___$H_2O\ (g)$

12. _____$Cu\ (s)$ + ____$AgNO_3\ (aq)$ → ____$Ag\ (s)$ + ____$Cu(NO_3)_2\ (aq)$

13. _____$C_{12}H_{22}O_{11}\ (s)$ + _____$O_2\ (g)$ → _____$CO_2\ (g)$ + _____$H_2O\ (g)$

14. _____$FeO\ (s)$ + _____$O_2\ (g)$ → _____$Fe_2O_3\ (s)$

15. _____$CS_2\ (l)$ + _____$NH_3\ (g)$ → _____$H_2S\ (g)$ + _____$NH_4SCN\ (s)$

16. ___$NaOH\ (aq)$ + ___$HNO_3\ (aq)$ → ___ $NaNO_3\ (aq)$ + ___$H_2O\ (l)$

Balancing Chemical Equations – Worksheet #2
Classifying Chemical Reactions

Most chemical reactions can be classified as one of these six basic reaction types:

- Synthesis (combination)
- Decomposition
- Single Replacement (oxidation-reduction)
- Double Replacement (precipitation)
- Acid-Base (neutralization)
- Combustion

Write balanced equations for each of the following examples:

1. **Synthesis Reaction: A + B → AB**
   Sodium (s) + chlorine (g) → sodium chloride (s)

2. **Decomposition Reaction: AB → A + B**
   sodium bicarbonate (s) → carbon dioxide (g) + sodium carbonate (s) + water (l)

3. **Single Replacement Reactions: AB + C → A + CB**
   hydrochloric acid, HCl (aq) + magnesium (s) → magnesium chloride (aq) + hydrogen (g)

4. **Double Replacement Reactions: AB + CD → _ AD + CB**
   calcium chloride (aq) + ammonium hydroxide (aq) → calcium hydroxide (s) + ammonium chloride (aq)

5. **Acid-Base Reactions: HA + BOH → BA + H_2O**
   Sulfuric Acid, H_2SO_4 (aq) + potassium hydroxide (aq) → potassium sulfate (aq) + water (l)

6. **Combustion Reactions: Fuel + O_2(g) → CO_2(g) + $H_2$0(g)**
   Hexane, C_6H_{14} (l) + oxygen (g) → carbon dioxide (g) + water (g)

Balancing Chemical Equations – Worksheet #3

Write balanced chemical equations for each of the following and then classify each reaction as a synthesis, decomposition, single-replacement, double replacement, acid-base reaction, or combustion. Be aware that some reactions may fall into more than one category.

Balanced Equation	Rxn Type
1. hydrogen (g) + chlorine (g) → hydrogen chloride (g)	
2. decane, $C_{10}H_{22}$ (l) + oxygen (g) → carbon dioxide (g) + water (g)	
3. magnesium chlorate (s) → magnesium chloride (s) + oxygen (g)	
4. iron (III) chloride (aq) + ammonium hydroxide (aq) → iron (III) hydroxide (s) + ammonium chloride (aq)	
5. chlorine (g) + aluminum iodide (s) → aluminum chloride (s) + iodine (s)	
6. iron (s) + oxygen (g) → iron (III) oxide (s)	
7. sulfuric acid (aq) + lithium hydroxide (aq) → water (l) + lithium sulfate (aq)	

Balanced Equation	Rxn Type
8. copper (s) + sulfur (s) → copper (I) sulfide (s)	
9. cesium bicarbonate (s) → carbon dioxide (g) + cesium carbonate (s) + water (l)	
10. sodium (s) + water (l) → sodium hydroxide (aq) + hydrogen (g)	
11. zinc (s) + chromium (III) chloride (aq) → chromium (s) + zinc chloride (aq)	
12. aluminum (s) + sulfuric acid (aq) → aluminum sulfate (aq) + hydrogen (g)	
13. potassium sulfate (aq) + barium chloride (aq) → potassium chloride (aq) + barium sulfate (s)	
14. glucose, $C_6H_{12}O_6$ (s) + oxygen (g) → carbon dioxide (g) + water (g)	
15. barium hydroxide (aq) + perchloric acid (aq) → water (l) + barium perchlorate (aq)	