Chemistry: Types of Chemical Reactions Guided Inquiry

Your goals for this lesson are to be able to:

- Look at the reactants and determine which one of the 5 reaction types will occur.
- Predict the products based on the reactants and the type of reaction.
- Write a balanced chemical equation.

You will complete the following graded learning activities:

- 5 online quick quizzes
- A flow chart for determining reaction type and products based on the reactants.

Introduction: Many, but not all, chemical reactions can be categorized into one of 5 types of reactions. If we are given the reactant(s), we can use the 5 reaction types to help us predict the products of the chemical reaction.

Study the video, Power Point presentation and the notes on the next page to understand the key characteristics of each type of reaction. Determine which of these characteristics can help you differentiate between the types of reactions. The following questions will help guide you through your investigation of the 5 reaction types.

1. What are the 5 major types of chemical reactions?
2. What is a general equation and why is it helpful in understanding the types of reactions?
3. What do the A, B, C and D represent in a general equation?
4. What are the key characteristics of a synthesis reaction?
   - Key characteristics include the number of reactants, the type of reactants (i.e. elements, ionic compounds, and molecular compounds), the number of products, and the type of products.
5. Why is “synthesis” a good name for this type of reaction?
6. What are the other two synonyms for a synthesis reaction?
7. What are the key characteristics of the following decomposition reactions?
   - a. Decomposition of a binary compound.
   - b. Decomposition of a metal carbonate.
   - c. Decomposition of a metal hydroxide.
   - d. Decomposition of a metal chlorate.
8. Why is “decomposition” a good name for these types of reactions?
9. What are the key characteristics of the following single replacement reactions?
   - a. Replacement of a metal by a more active metal.
   - b. Replacement of hydrogen in water by a more active Group 1 metal.
   - c. Replacement of hydrogen in water by a more active Group 2 or transition metal.
   - d. Replacement of hydrogen in an acid by a more reactive metal.
   - e. Replacement of a halogen by a more active halogen.
10. Why is “single replacement” a good name for these types of reactions?
11. What are the key characteristics of a double replacement reaction?
12. What are the 3 possible outcomes of a double replacement reaction?
13. Which of these three outcomes could you observe in the lab using one of your 5 senses?
14. Which of these three outcomes could not be readily observed in the lab?
15. What are the key characteristics of a hydrocarbon combustion reaction?
16. In addition to new substances what else is produced in a combustion reaction?
17. Give some examples of combustion reactions that you use or see being used in everyday life?
Notes on the 5 Reaction Types

**Synthesis (aka Composition or Combination) Reaction**

a. General Equation
   \[ A + B \rightarrow AB \]

b. Oxygen reacts with metals to form metal oxides.
   \[ O_2 + 2 \text{Mg} \rightarrow 2 \text{MgO} \]

c. Two nonmetals react to form a covalent bond.
   \[ \text{S} + \text{O}_2 \rightarrow \text{SO}_2 \]

d. Metals react with nonmetals to form ionic "salts".
   \[ \text{Mg} + \text{Cl}_2 \rightarrow \text{MgCl}_2 \]

**Decomposition Reaction**

a. General Equation
   \[ \text{AB} \rightarrow \text{A} + \text{B} \]

b. Decomposition of binary compounds.
   \[ 2\text{NaCl} \rightarrow 2\text{Na} + \text{Cl}_2 \]

c. Decomposition of metal carbonates to form metal oxides and carbon dioxide.
   \[ \text{CaCO}_3 \rightarrow \text{CaO} + \text{CO}_2 \]

d. Decomposition of metal hydroxides to form metal oxides and water.
   \[ \text{Mg(OH)}_2 \rightarrow \text{MgO} + \text{H}_2\text{O} \]

e. Decomposition of metal chlorates to form metal chlorides and oxygen.
   \[ 2\text{KClO}_3 \rightarrow 2\text{KCl} + 3\text{O}_2 \]

**Combustion of Hydrocarbons**

a. General Equation
   \[ \text{hydrocarbon} + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O} \]

b. Combustion of Propane.
   \[ \text{C}_3\text{H}_8 + 5\text{O}_2 \rightarrow 3\text{CO}_2 + 4\text{H}_2\text{O} \]

**Single Replacement Reaction**

a. General Equation
   \[ A + \text{BC} \rightarrow \text{AC} + \text{B} \] (or) \[ Y + \text{BC} \rightarrow \text{BY} + \text{C} \]

b. Replacement of metal by more active metal.
   \[ 2\text{Al} + 3\text{Fe(NO}_3)_2 \rightarrow 3\text{Fe} + 2\text{Al(NO}_3)_3 \]

c. Replacement of hydrogen in water by a more reactive Group 1 metal.
   \[ 2\text{Na} + 2\text{H}_2\text{O} \rightarrow 2\text{NaOH} + \text{H}_2 \]

d. Replacement of hydrogen in water by a more reactive Group 2 or transition metal.
   \[ \text{Mg} + \text{H}_2\text{O} \rightarrow \text{MgO} + \text{H}_2 \]

e. Replacement of hydrogen in an acid by a more reactive metal.
   \[ \text{Mg} + 2\text{HCl} \rightarrow \text{MgCl}_2 + \text{H}_2 \]

f. Replacement of a halogen (nonmetal) by a more reactive halogen.
   \[ \text{Cl}_2 + 2\text{NaBr} \rightarrow 2\text{NaCl} + \text{Br}_2 \]

**Double Replacement Reaction**

a. Formation of a precipitate (insoluble substance).
   \[ \text{Pb(NO}_3)_2 + 2\text{NaI} \rightarrow \text{Pbl}_2 + 2\text{NaNO}_3 \]

b. Formation of a gas.
   \[ \text{CaCO}_3 + 2\text{HCl} \rightarrow \text{CaCl}_2 + \text{H}_2\text{O} + \text{CO}_2 \]

c. Formation of water (acid/base neutralization).
   \[ \text{H}_2\text{SO}_4 + 2\text{NaOH} \rightarrow \text{Na}_2\text{SO}_4 + 2\text{H}_2\text{O} \]

→ Watch the **Synthesis (combination) Reaction quick quiz**.

→ Watch the **Decomposition Reaction quick quiz**.

→ Watch the **Combustion Reaction quick quiz**.

→ Watch the **Single Replacement quick quiz**.

→ Watch the **Double Replacement quick quiz**.

→ **Assignment:** Create a flow chart that shows your decision making process for identifying the reaction type and products based on the reactants. **Turn in your concept map the day of the quiz.**