

TYPES OF CHEMICAL REACTIONS

All chemical reactions can be placed into one of six categories. Here they are, in no particular order:

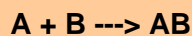
- 1) **Combustion:** A combustion reaction is when oxygen combines with another compound to form water and carbon dioxide. These reactions are exothermic, meaning they produce heat.



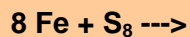
An example of this kind of reaction is the burning of naphthalene:



- 2) **Synthesis:** A synthesis reaction is when two or more simple compounds combine to form a more complicated one. These reactions come in the general form of:

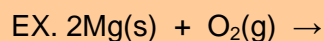


One example of a synthesis reaction is the combination of iron and sulfur to form iron (II) sulfide:



Common examples of synthesis reactions:

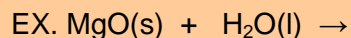
1. **Metal + oxygen** → **metal oxide**



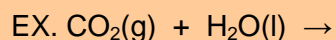
2. **Nonmetal + oxygen** → **nonmetallic oxide**



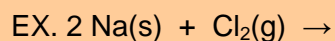
3. **Metal oxide + water** → **metallic hydroxide**



4. **Nonmetallic oxide + water** → **acid**



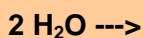
5. **Metal + nonmetal** → **salt**



3) **Decomposition:** A decomposition reaction is the opposite of a synthesis reaction - a complex molecule breaks down to make simpler ones. These reactions come in the general form:



One example of a decomposition reaction is the electrolysis of water to make oxygen and hydrogen gas:

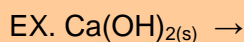


Common examples of decomposition reactions:

1. **Metallic carbonates, when heated, form metallic oxides and $\text{CO}_{2(g)}$.**



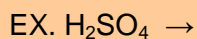
2. **Most metallic hydroxides, when heated, decompose into metallic oxides and water.**



3. **Metallic chlorates, when heated, decompose into metallic chlorides and oxygen.**



4. **Some acids, when heated, decompose into nonmetallic oxides and water.**



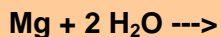
4) **Single displacement:** This is when one element trades places with another element in a compound. These reactions come in the general form of:



Typically, this is a simple switch of elements (positive or negative) like the example below:



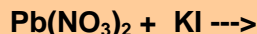
When a metal reacts with water, however, it will react by forming a metal hydroxide and hydrogen gas, as in the example below:



5) **Double displacement:** This is when the anions and cations of two different molecules switch places, forming two entirely different compounds. **Basically switch the first elements in each compound of the reactants and balance the charges to make the products.** These reactions are in the general form:



One example of a double displacement reaction is the reaction of lead (II) nitrate with potassium iodide to form lead (II) iodide and potassium nitrate:



6) **Acid-base:** This is a special kind of double displacement reaction that takes place when an acid and base react with each other. The H^+ ion in the acid reacts with the OH^- ion in the base, causing the formation of water. Generally, the product of this reaction is some ionic salt and water:



One example of an acid-base reaction is the reaction of hydrobromic acid (HBr) with sodium hydroxide:



A Handy Checklist for figuring out what type of reaction is taking place:

Follow this series of questions. When you can answer "yes" to a question, then stop!

- 1) Does your reaction have oxygen as one of its reactants and carbon dioxide and water as products? If yes, then it's a combustion reaction
- 2) Does your reaction have two (or more) chemicals combining to form one chemical? If yes, then it's a synthesis reaction
- 3) Does your reaction have one large molecule falling apart to make several small ones? If yes, then it's a decomposition reaction
- 4) Does your reaction have any molecules that contain only one element? If yes, then it's a single displacement reaction
- 5) Does your reaction have water as one of the products? If yes, then it's an acid-base reaction
- 6) If you haven't answered "yes" to any of the questions above, then you've got a double displacement reaction

Sample Problems

List what type the following reactions are:

- 1) $\text{NaOH} + \text{KNO}_3 \rightarrow \text{NaNO}_3 + \text{KOH}$
- 2) $\text{CH}_4 + 2 \text{O}_2 \rightarrow \text{CO}_2 + 2 \text{H}_2\text{O}$
- 3) $2 \text{Fe} + 6 \text{NaBr} \rightarrow 2 \text{FeBr}_3 + 6 \text{Na}$
- 4) $\text{CaSO}_4 + \text{Mg}(\text{OH})_2 \rightarrow \text{Ca}(\text{OH})_2 + \text{MgSO}_4$
- 5) $\text{NH}_4\text{OH} + \text{HBr} \rightarrow \text{H}_2\text{O} + \text{NH}_4\text{Br}$
- 6) $\text{Pb} + \text{O}_2 \rightarrow \text{PbO}_2$
- 7) $\text{Na}_2\text{CO}_3 \rightarrow \text{Na}_2\text{O} + \text{CO}_2$

Predicting Products – identify the TYPE of reaction, then predict the products of the reactions below and balance.

- 8) _____ $\text{C}_3\text{H}_6 + \text{O}_2 \rightarrow$
- 9) _____ $\text{NaI} + \text{CaSO}_4 \rightarrow$
- 10) _____ $\text{HNO}_3 + \text{Ca}(\text{OH})_2 \rightarrow$
- 11) _____ $\text{CaCO}_3 \rightarrow$
- 12) _____ $\text{Pb} + \text{Fe}(\text{NO}_3)_3 \rightarrow$