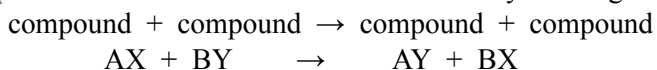


9:3 Classifying Chemical Changes - Double and Single Displacement Reactions

Double Displacement

Double Displacement Reactions happen when the positive and negative ions of two compounds switch partners. The form of these reactions is easy to recognize.



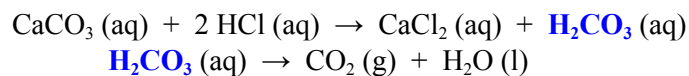
Remember that the positive ions (written first) can only join with negative ions (written second). It is also important to note that two solid chemicals will generally not react. In order for the ions to have access, at least one of them will need to be aqueous. Also, one of the products *must change* into an insoluble compound called a **precipitate** or into a covalent compound as in the formation of water (l).

When assigning phases to the products use the table of solubilities. It is important to follow the aqueous aspect through the reaction. If both of your reactants are dissolved in water, the water remains somewhere, meaning that one of the products will also have to be dissolved in water - aqueous.

The following are some general types of double displacement reactions.

1. A reaction between an acid and a base yields a salt and water. Such a reaction is called a neutralization reaction. The water is a covalent compound therefore this is a chemical change.
$$2 \text{KOH (aq)} + \text{H}_2\text{SO}_4 \text{ (aq)} \rightarrow \text{K}_2\text{SO}_4 \text{ (aq)} + 2 \text{HOH (l)} \text{ (water written in acid/base form)}$$
2. Reaction of a salt with an acid forms a salt of the acid and a second acid that is volatile (bubbles away as a gas).
$$2 \text{KNO}_3 \text{ (aq)} + \text{H}_2\text{SO}_4 \text{ (aq)} \rightarrow \text{K}_2\text{SO}_4 \text{ (aq)} + 2 \text{HNO}_3 \text{ (g)}$$

This same reaction of a salt with an acid or base may yield a compound that can be decomposed. $\text{H}_2\text{CO}_3 \text{ (aq)}$, $\text{H}_2\text{SO}_3 \text{ (aq)}$, and $\text{NH}_3 \text{ (aq)}$ decompose to give a gas and water.



3. Reactions of some soluble salts produce an insoluble salt that precipitates out and a soluble salt that remains in solution.
$$\text{AgNO}_3 \text{ (aq)} + \text{NaCl (aq)} \rightarrow \text{AgCl (cr)} + \text{NaNO}_3 \text{ (aq)}$$

Problems:

Balance the following equations.

1. $\text{Ca(OH)}_2 \text{ (aq)} + \text{HCl (aq)} \rightarrow \text{CaCl}_2 \text{ (aq)} + \text{HOH (l)}$
2. $\text{KOH (aq)} + \text{H}_3\text{PO}_4 \text{ (aq)} \rightarrow \text{K}_3\text{PO}_4 \text{ (aq)} + \text{HOH (l)}$
3. $\text{Al(NO}_3)_3 \text{ (aq)} + \text{H}_2\text{SO}_4 \text{ (aq)} \rightarrow \text{Al}_2(\text{SO}_4)_3 \text{ (aq)} + \text{HNO}_3 \text{ (aq)}$
4. $\text{Na}_2\text{SO}_3 \text{ (aq)} + \text{HCl (aq)} \rightarrow \text{NaCl (aq)} + \text{H}_2\text{O (l)} + \text{SO}_2 \text{ (g)}$

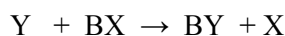
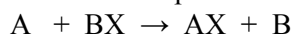
Balance each of the following reactions after predicting the products

5. sodium hydroxide (aq) + phosphoric acid (aq) →
6. ammonium sulfate (aq) + calcium hydroxide (aq) →
7. silver nitrate (aq) + potassium chloride (aq) →
8. magnesium hydroxide (aq) + phosphoric acid (aq) →
9. iron (II) sulfide (cr) + hydrochloric acid (aq) →
10. Ammonium sulfide (aq) + iron (II) nitrate (aq) →

Single Displacement

One element displaces another element in a compound. A single displacement has the general form:

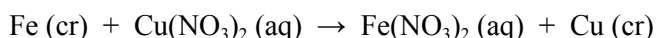
Element + compound → element + compound



Those elements that form positive ions will replace only positive ions and those elements that tend to form negative ions will replace only negative ions. Whether or not a single displacement reaction will occur is determined from the Activity Series. Those elements higher in the series are more reactive than those below and will react to displace the lower element from a compound. There is a series for those elements that tend to form positive ions and another series for the halogens. Just because you can write a reaction equation doesn't mean it will occur. **If an element trying to displace is lower than the element in the compound, the reaction will not occur.** Then write NO REACTION as the product.

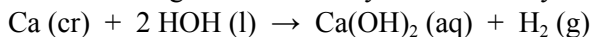
The following are some general types of single displacement reactions.

1. An active metal will displace the metallic ion in a compound of a less active metal.

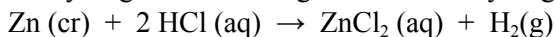


Iron is higher on the activity series than copper.

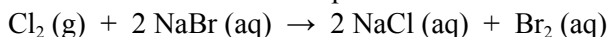
2. Some active metals such as sodium and calcium will react with water to give a metallic hydroxide and hydrogen gas.



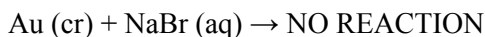
3. Active metals such as zinc, iron, and aluminum will displace the hydrogen in acids to give a salt and hydrogen gas.



4. An active nonmetal will displace a less active nonmetal.



5. Metals below active metals cannot replace more active metals.



Activity of Metals

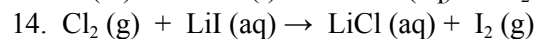
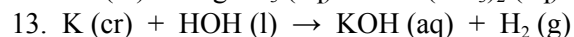
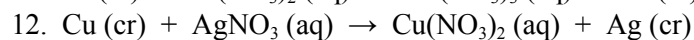
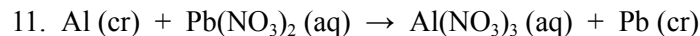
Li	react with cold H ₂ O and acids, replacing hydrogen; react with oxygen, forming oxides
Rb	
K	
Ca	
Ba	
Sr	react with steam (but not cold water) and acids; replacing hydrogen; react with oxygen, forming oxides
Ca	
Na	
Mg	
Al	
Mn	do not react with water; react with acids, replacing hydrogen; react with oxygen, forming oxides
Zn	
Cr	
Fe	
Cd	
Co	react with oxygen, forming oxides
Ni	
Sn	
Pb	
H ₂	
Sb	fairly unreactive, forming oxides only indirectly
Bi	
Cu	
Hg	
Ag	
Pt	
Au	

Activity of Halogens

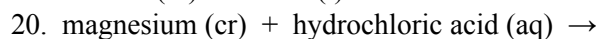
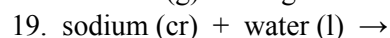
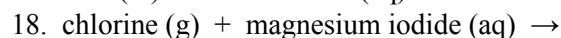
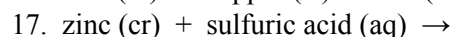
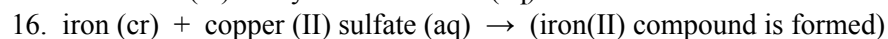
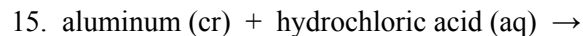
F ₂
Cl ₂
Br ₂
I ₂

Problems:

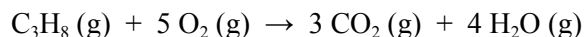
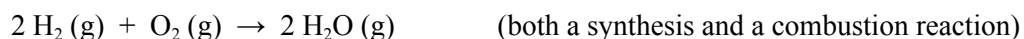
Balance the following reactions.



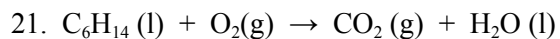
Balance each of the following reactions after predicting the products.

**Combustion Reactions**

In a combustion reaction, a substance combines with oxygen, releasing a large amount of energy in the form of light and heat. The burning of natural gas, propane, gasoline, and wood are also examples of combustion reactions. In the presence of carbon, the products of a combustion reaction are always carbon dioxide and water. Examples of combustion reactions include the following.

**Problems:**

Balance the following reaction:



Balance the following reactions after predicting the products.

