

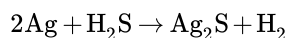
10.4.4: Single Displacement/Replacement Reactions



Figure 10.4.4.1 (Credit: wisteriax; Source: [https://pixabay.com/photos/still-life-silver-poppies-2312788/\(opens in new window\)](https://pixabay.com/photos/still-life-silver-poppies-2312788/(opens in new window)); License: Pixabay License)

Why is the silver dark?

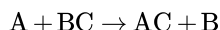
The platter and pitcher shown above provides an example of tarnish, a chemical reaction caused when silver metal reacts with hydrogen sulfide gas produced by some industrial processes or as a result of decaying animal or plant materials:



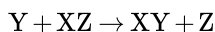
The tarnish can be removed using a number of polishes, but the process also removes a small amount of silver along with the tarnish.

Single-Replacement Reactions

A **single-replacement reaction** is a reaction in which one element replaces a similar element in a compound. The general form of a single-replacement (also called single-displacement) reaction is:



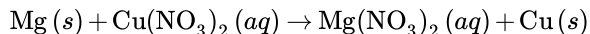
In this general reaction, element A is a metal and replaces element B (also a metal) in the compound. When the element that is doing the replacing is a nonmetal, it must replace another nonmetal in a compound, and the general equation becomes:



(Where Y is a nonmetal and replaces the nonmetal Z in the compound with X.)

Metal Replacement

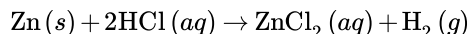
Magnesium is a more reactive metal than copper. When a strip of magnesium metal is placed in an aqueous solution of copper (II) nitrate, it replaces the copper. The products of the reaction are aqueous magnesium nitrate and solid copper metal.



This subcategory of single-replacement reactions is called a metal replacement reaction because it is a metal that is being replaced (copper).

Hydrogen Replacement

Many metals react easily with acids and when they do so, one of the products of the reaction is hydrogen gas. Zinc reacts with hydrochloric acid to produce aqueous zinc chloride and hydrogen (figure below).



In a hydrogen replacement reaction, the hydrogen in the acid is replaced by an active metal.



Figure 10.4.4.2: Zinc metal reacts with hydrochloric acid to give off hydrogen gas in a single-displacement reaction. (Credit: User: Chemicalinterest/Wikimedia Commons; Source: http://commons.wikimedia.org/wiki/File:Zn_reaction_with_HCl.JPG(opens in new window); License: Public Domain)

Some metals are so reactive that they are capable of replacing the hydrogen in water. The products of such a reaction are the metal hydroxide and hydrogen gas. All group 1 metals undergo this type of reaction. Sodium reacts vigorously with water to produce aqueous sodium hydroxide and hydrogen (see figure below).

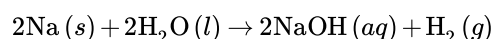
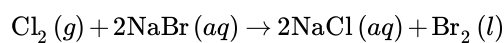


Figure 10.4.4.3: Sodium metal reacts vigorously with water, giving off hydrogen gas. A large piece of sodium will often generate so much heat that the hydrogen will ignite. (Credit: User:Ajhalls/Wikimedia Commons; Source: http://commons.wikimedia.org/wiki/File:Large_Sodium_Explosion.jpg(opens in new window); License: Public Domain)

Halogen Replacement

The element chlorine reacts with an aqueous solution of sodium bromide to produce aqueous sodium chloride and elemental bromine:



The reactivity of the halogen group (group 17) decreases from top to bottom within the group. Fluorine is the most reactive halogen, while iodine is the least. Since chlorine is above bromine, it is more reactive than bromine and can replace it in a halogen replacement reaction.



Summary

- The activity series describes the relative reactivities of metals and halogens.

Review

1. What is a metal replacement reaction?
2. Will a non-metal replace a metal?
3. What is the most reactive halogen?
4. What products will I get if I add potassium metal to water?

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