

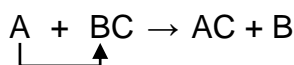


## Single Replacement Reactions

In single replacement reactions, one element reacts with a compound by replacing one of the elements within the compound.

### REPLACING A CATION

A metal can replace a metal ion in a salt, or a hydrogen ion in an acid:



1) Element A must be more reactive than B to displace B from the compound BC. If B were more reactive than A, no displacement would occur.

2) It is possible to arrange the metals in a series called the **electromotive series** or **activity series**. An activity series is provided on the right. Elements that are higher on the activity series have a greater tendency to lose electrons than those below it. Thus, an element will displace any element below it in the activity series from a compound.

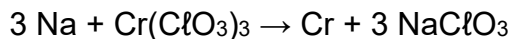
In general, within a family of representative metals, the larger metals tend to be more reactive. They have lower ionization energies; therefore they tend to lose electrons more easily than smaller metals. Truthfully, if you compare the activity series to the positions these elements hold on the periodic table, you'll see that it's quite hard to predict which element is higher on the activity series from the table. This is why we use the activity series and not the periodic table when answering this sort of question.

*Example 1:* Complete and balance the following single replacement reactions, if they would occur:

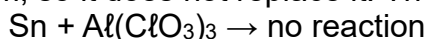
- 1)  $\text{Na} + \text{Cr}(\text{ClO}_3)_3 \rightarrow$
- 2)  $\text{Sn} + \text{Al}(\text{ClO}_3)_3 \rightarrow$

*Solution:* First we look on the activity table to decide whether the reactions would occur at all.

(1) Sodium is higher than chromium so it would replace chromium in a single replacement. Since the sodium ion is  $\text{Na}^+$ , the products will be Cr and  $\text{NaClO}_3$ . We balance the resulting equations:



(2) Tin is lower than aluminum, so it does not replace it. There is no reaction.

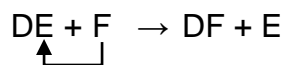


lithium	Li
potassium	K
barium	Ba
calcium	Ca
sodium	Na
magnesium	Mg
aluminum	Al
manganese	Mn
zinc	Zn
chromium	Cr
iron	Fe
cadmium	Cd
nickel	Ni
tin	Sn
lead	Pb
hydrogen	H
antimony	Sb
bismuth	Bi
copper	Cu
mercury	Hg
silver	Ag
gold	Au



## REPLACING AN ANION (OPTIONAL)

A nonmetal can replace a nonmetal ion in a salt or acid:



1) Again, element F must be more reactive than E in order to displace E from the compound DE. If E were more reactive than F, no displacement would have occurred.

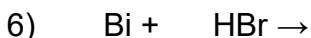
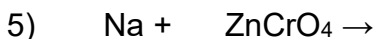
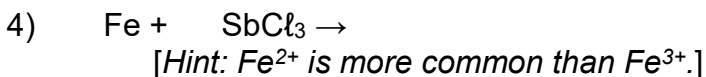
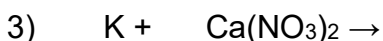
2) A similar activity series can be prepared for the halogen nonmetals. It appears at the right.

fluorine	F <sub>2</sub>
chlorine	Cl <sub>2</sub>
bromine	Br <sub>2</sub>
iodine	I <sub>2</sub>

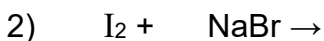
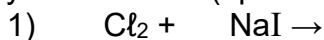
lithium	Li
potassium	K
barium	Ba
calcium	Ca
sodium	Na
magnesium	Mg
aluminum	Al
manganese	Mn
zinc	Zn
chromium	Cr
iron	Fe
cadmium	Cd
nickel	Ni
tin	Sn
lead	Pb
hydrogen	H
antimony	Sb
bismuth	Bi
copper	Cu
mercury	Hg
silver	Ag
gold	Au

## EXERCISES

A. Complete and balance the following single replacement reactions, if they would occur:



B. Complete and balance the following single replacement reactions, if they would occur (optional):



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## SOLUTIONS

- A. (1)  $2 \text{Al} + 3 \text{CuSO}_4 \rightarrow 3 \text{Cu} + \text{Al}_2(\text{SO}_4)_3$  (2) no reaction  
(3)  $2 \text{K} + \text{Ca}(\text{NO}_3)_2 \rightarrow \text{Ca} + 2 \text{KNO}_3$  (4)  $3 \text{Fe} + 2 \text{SbCl}_3 \rightarrow 2 \text{Sb} + 3 \text{FeCl}_2$   
(5)  $2 \text{Na} + \text{ZnCrO}_4 \rightarrow \text{Zn} + \text{Na}_2\text{CrO}_4$  (6) no reaction
- B. (1)  $\text{Cl}_2 + 2 \text{NaI} \rightarrow \text{I}_2 + 2 \text{NaCl}$  (2) no reaction

