

Single Displacement Reactions

- Single displacement reactions occur when one element replaces another similar element in a compound.
- In order to determine if a reaction is going to take place, you need to refer to an activity series.
- An activity series is a list of how reactive an element is, and is based off of that element's electronegativity.

Single Displacement Reactions Involving Metals

- Most single displacement reactions involve a metal replacing another metal

Example: Copper reacts with silver nitrate

Example: Magnesium reacts with hydrochloric acid

*In this case, we treat hydrogen as a metal

Using the Activity series of metals

- An activity series is a list of substances ranked in order of relative reactivity, starting with the most reactive. It is derived experimentally by looking at reactivity with water and acids.
- A reactive metal will displace any metal in a compound that is below it on the series.

Example: Iron reacts with copper (II) sulfate

Example: Silver reacts with calcium chloride

Activity Series		
Metal	Common Ions	Reactivity
lithium	Li^{+1}	most reactive
potassium	K^{+1}	These metals displace hydrogen from water: $\text{Ca(s)} + 2\text{H}_2\text{O(l)} \rightarrow \text{Ca(OH)}_2 + \text{H}_2\text{(g)}$ They react readily to form compounds.
strontium	Sr^{+2}	
calcium	Ca^{+2}	
sodium	Na^{+1}	
magnesium	Mg^{+2}	
aluminum	Al^{+3}	These metals displace hydrogen from acids: $\text{Zn(s)} + \text{HCl(aq)} \rightarrow \text{ZnCl}_2 + \text{H}_2\text{(g)}$
zinc	Zn^{+2}	
chromium	$\text{Cr}^{+2}, \text{Cr}^{+3}$	
iron	$\text{Fe}^{+2}, \text{Fe}^{+3}$	
cadmium	Cd^{+2}	
cobalt	$\text{Co}^{+2}, \text{Co}^{+3}$	
nickel	Ni^{+2}	
tin	$\text{Sn}^{+2}, \text{Sn}^{+4}$	
lead	$\text{Pb}^{+2}, \text{Pb}^{+4}$	
hydrogen	H^{+1}	
antimony	$\text{Sb}^{+3}, \text{Sb}^{+5}$	These metals do not displace hydrogen from acids.
arsenic	$\text{As}^{+3}, \text{As}^{+5}$	
bismuth	Bi^{+3}	
copper	$\text{Cu}^{+1}, \text{Cu}^{+2}$	
mercury	$\text{Hg}^{+1}, \text{Hg}^{+2}$	These metals are more stable, forming compounds less readily than those higher on the table.
silver	Ag^{+1}	
platinum	Pt^{+2}	
gold	$\text{Au}^{+1}, \text{Au}^{+3}$	

Single Displacement Reactions Involving Halogens

- Non-metals can also take place in single displacement reactions.
- The activity series for halogens directly mirrors their position on the periodic table with $F > Cl > Br > I$.

Example: Chlorine gas reacts with potassium bromide

Example: Iodine reacts with calcium bromide

Double Displacement Reactions

- A double displacement reaction involves the exchange of cations between two ionic compounds.

Precipitate Reactions

- A precipitate is a solid that separates from a solution in a chemical reaction.
- In order to predict whether a precipitation reaction will take place, you need to consult a solubility table.
- If a precipitate forms, that compound will be represented by a (s).
- If no precipitate forms, no reaction will take place.

Table 17.3 Solubilities of Ionic Compounds* aq = aqueous (dissolves in water); s = solid (does not dissolve in water)

Ions	Acetate	Bromide	Carbonate	Chlorate	Chloride	Fluoride	Hydrogen Carbonate	Hydroxide	Iodide	Nitrate	Nitrite	Phosphate	Sulfate	Sulfide	Sulfite
Aluminum	s	aq		aq	aq	s		s	—	aq		s	aq	—	
Ammonium	aq	aq	aq	aq	aq	aq	aq	—	aq	aq	aq	aq	aq	aq	aq
Barium	aq	aq	s	aq	aq	s		aq	aq	aq	aq	s	s	—	s
Calcium	aq	aq	s	aq	aq	s		s	aq	aq	aq	s	s	—	s
Cobalt(II)	aq	aq	s	aq	aq	—		s	aq	aq		s	aq	s	s
Copper(II)	aq	aq	s	aq	aq	aq		s		aq		s	aq	s	
Iron(II)	aq	aq	s		aq	s		s	aq	aq		s	aq	s	s
Iron(III)	—	aq			aq	s		s	aq	aq		s	aq	—	
Lead(II)	aq	s	s	aq	s	s		s	s	aq	aq	s	s	s	s
Lithium	aq	aq	aq	aq	aq	aq	aq	aq	aq	aq	aq	s	aq	aq	aq
Magnesium	aq	aq	s	aq	aq	s		s	aq	aq	aq	s	aq	—	aq
Nickel	aq	aq	s	aq	aq	aq		s	aq	aq		s	aq	s	s
Potassium	aq	aq	aq	aq	aq	aq	aq	aq	aq	aq	aq	aq	aq	aq	aq
Silver	s	s	s	aq	s	aq		—	s	aq	s	s	s	s	s
Sodium	aq	aq	aq	aq	aq	aq	aq	aq	aq	aq	aq	aq	aq	aq	aq
Zinc	aq	aq	s	aq	aq	aq		s	aq	aq		s	aq	s	s

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Example: magnesium chloride reacts with calcium hydroxide

Example: barium chloride reacts with potassium sulfate

Example: magnesium chloride reacts with potassium sulfate

Gas Producing Reactions

- A double displacement reaction will take place if the reaction produces a gas.

Example: sodium sulfide reacts with hydrochloric acid

Neutralization Reactions

- When an acid and base are mixed, water will be produced as a water and a salt.

Example: aqueous magnesium hydroxide reacts with aqueous hydrogen chloride