

3. Single Displacement Reactions

- ❑ Also known as: oxidation-reduction reactions
- ❑ An element reacts with a compound and displaces a second element from the compound to form an element and a new compound
- ❑ General form: $A + BC \rightarrow AC + B$
- ❑ *Don't forget to follow the activity/reactivity series. Some reactions will not occur.

Activity Series


TABLE 4.5 Activity Series of Metals in Aqueous Solution

Metal	Oxidation Reaction				
Lithium	Li(s)	\longrightarrow	$\text{Li}^+(\text{aq})$	+	e^-
Potassium	K(s)	\longrightarrow	$\text{K}^+(\text{aq})$	+	e^-
Barium	Ba(s)	\longrightarrow	$\text{Ba}^{2+}(\text{aq})$	+	2e^-
Calcium	Ca(s)	\longrightarrow	$\text{Ca}^{2+}(\text{aq})$	+	2e^-
Sodium	Na(s)	\longrightarrow	$\text{Na}^+(\text{aq})$	+	e^-
Magnesium	Mg(s)	\longrightarrow	$\text{Mg}^{2+}(\text{aq})$	+	2e^-
Aluminum	Al(s)	\longrightarrow	$\text{Al}^{3+}(\text{aq})$	+	3e^-
Manganese	Mn(s)	\longrightarrow	$\text{Mn}^{2+}(\text{aq})$	+	2e^-
Zinc	Zn(s)	\longrightarrow	$\text{Zn}^{2+}(\text{aq})$	+	2e^-
Chromium	Cr(s)	\longrightarrow	$\text{Cr}^{3+}(\text{aq})$	+	3e^-
Iron	Fe(s)	\longrightarrow	$\text{Fe}^{2+}(\text{aq})$	+	2e^-
Cobalt	Co(s)	\longrightarrow	$\text{Co}^{2+}(\text{aq})$	+	2e^-
Nickel	Ni(s)	\longrightarrow	$\text{Ni}^{2+}(\text{aq})$	+	2e^-
Tin	Sn(s)	\longrightarrow	$\text{Sn}^{2+}(\text{aq})$	+	2e^-
Lead	Pb(s)	\longrightarrow	$\text{Pb}^{2+}(\text{aq})$	+	2e^-
Hydrogen	$\text{H}_2(\text{g})$	\longrightarrow	$2\text{H}^+(\text{aq})$	+	2e^-
Copper	Cu(s)	\longrightarrow	$\text{Cu}^{2+}(\text{aq})$	+	2e^-
Silver	Ag(s)	\longrightarrow	$\text{Ag}^+(\text{aq})$	+	e^-
Mercury	Hg(l)	\longrightarrow	$\text{Hg}^{2+}(\text{aq})$	+	2e^-
Platinum	Pt(s)	\longrightarrow	$\text{Pt}^{2+}(\text{aq})$	+	2e^-
Gold	Au(s)	\longrightarrow	$\text{Au}^{3+}(\text{aq})$	+	3e^-



Ease of oxidation increases

potassium	most reactive	K
sodium		Na
calcium		Ca
magnesium		Mg
aluminium		Al
carbon		C
zinc		Zn
iron		Fe
tin		Sn
lead		Pb
hydrogen		H
copper		Cu
silver		Ag
gold		Au
platinum	least reactive	Pt

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- Single displacement reactions usually occur between the following combinations:

- a) **an active metal + an acid**

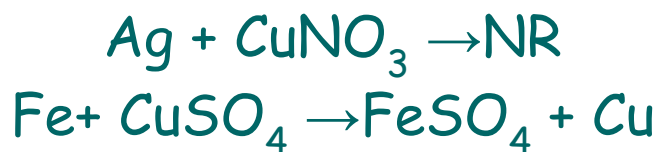
- ✓ When a solo metal is ABOVE hydrogen (compound) in the activity series, the solo metal will DISPLACE hydrogen.
Examples:



b)

A metal + a salt

- ✓ Each solo metal in the activity series displaces any metal below it to form a salt in solution.



c) **A Halogen + halide salt**

- ✓ A solo halogen will displace any less active halogen from a halide salt. The reactivity of halogens is: $\text{F}_2 > \text{Cl}_2 > \text{Br}_2 > \text{I}_2$.



4. Double Displacement Reactions



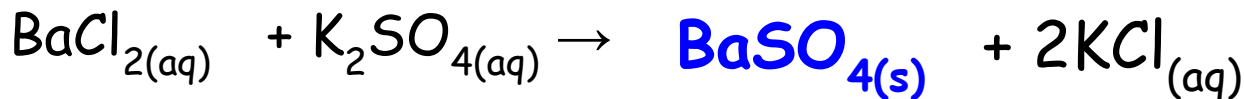
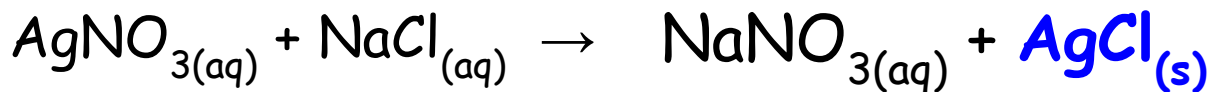
- There are usually 2 types of these reactions :
 - ✓ **Precipitation reactions** - formation of an insoluble compound called a precipitate
 - ✓ **Neutralization reactions** - formation of water and a salt

***Note:** The valence of multivalent elements stays the same on both sides of the equation

a) Precipitation Reactions:

- ✓ Two compounds which are water soluble react to form two new compounds, one of which is a precipitate (ie. insoluble in water).
- ✓ In order to determine which one of the products will be the precipitate requires knowledge of the solubilities of salts in water * see solubility table

Examples: Predict the products for each reaction



How to read the solubility chart

- $\text{NaNO}_3(\text{aq})$
- Look up Nitrate...
notice it says they
are ALL soluble.
Therefore, Sodium
Nitrate is (aq)
meaning it stays
dissolved in the
solution.

Ion	Solubility	Exceptions
NO_3^-	soluble	none
ClO_4^-	soluble	none
Cl^-	soluble	except Ag^+ , Hg_2^{2+} , Pb^{2+}
I^-	soluble	except Ag^+ , Hg_2^{2+} , Pb^{2+}
SO_4^{2-}	soluble	except Ca^{2+} , Ba^{2+} , Sr^{2+} , Hg^{2+} , Pb^{2+} , Ag^+
CO_3^{2-}	insoluble	except Group IA and NH_4^+
PO_4^{3-}	insoluble	except Group IA and NH_4^+
-OH	insoluble	except Group IA, *Ca^{2+} , Ba^{2+} , Sr^{2+}
S^{2-}	insoluble	except Group IA, IIA and NH_4^+
Na^+	soluble	none
NH_4^+	soluble	none
K^+	soluble	none

*slightly soluble

How to read the solubility chart

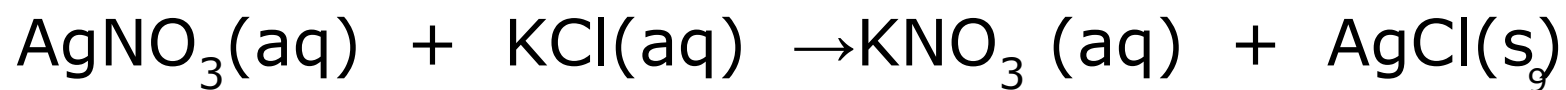


- Look up Chlorides. Notice it says Chlorides are SOLUBLE.
- However, Ag (Silver) is an EXCEPTION. This means that most chloride compounds are soluble but Silver Chloride is not. It will be a solid precipitate.

Ion	Solubility	Exceptions
NO_3^-	soluble	none
ClO_4^-	soluble	none
Cl^-	soluble	except Ag^+ , Hg_2^{2+} , Pb^{2+}
I^-	soluble	except Ag^+ , Hg_2^{2+} , Pb^{2+}
SO_4^{2-}	soluble	except Ca^{2+} , Ba^{2+} , Sr^{2+} , Hg^{2+} , Pb^{2+} , Ag^+
CO_3^{2-}	insoluble	except Group IA and NH_4^+
PO_4^{3-}	insoluble	except Group IA and NH_4^+
-OH	insoluble	except Group IA, Ca^{2+} , Ba^{2+} , Sr^{2+}
S^{2-}	insoluble	except Group IA, IIA and NH_4^+
Na^+	soluble	none
NH_4^+	soluble	none
K^+	soluble	none

*slightly soluble

Formation of a solid: AgCl

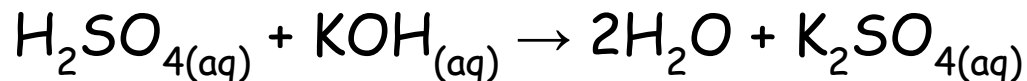
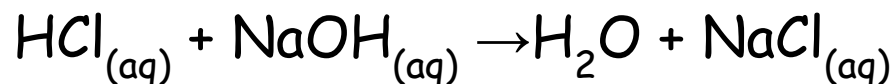


b) Neutralization Reactions

(sometimes called acid- base reactions)

- ✓ A neutralization reaction occurs between an acidic compound and a basic compound to form a chemical salt and water.
- ✓ The pH is equal to 7 if all acid/base completely reacts
- ✓ Use bromothymol blue as indicator - turns green

Examples:



5. Combustion - burning a hydrocarbon

- ❑ A hydrocarbon is a molecular compound containing only carbon, hydrogen and sometimes oxygen.
- ❑ Complete combustion of a hydrocarbon **always** produces only 2 products: CO_2 and H_2O
- ❑ Example: Write a balance chemical equation for the combustion of propane (C_3H_8).

