

Ch 8 Single replacement reactions

- ◆ $A + BX \rightarrow AX + B$
- ◆ You will have a chart of activity series
- ◆ More active metals will replace less active metals from their compound in a solution
- ◆ A less active element will have no reaction when added to a more active element!
- ◆ Active metals replace hydrogen in water
- ◆ Active metals replace hydrogen in acids
- ◆ Active nonmetals replace less active nonmetals from their compounds in solutions

Using the chart

- ◆ Only a reaction with a **positive** E will occur
- ◆ Magnesium reacts with Copper II nitrate
- ◆ The single replacement would be...
- ◆ $Mg + Cu(NO_3)_2 \rightarrow Mg(NO_3)_2 + Cu$
- ◆ But will this actually occur?
- ◆ Separating to ions
- ◆ $Mg + Cu^{2+} + 2 NO_3^- \rightarrow Mg^{2+} + 2NO_3^- + Cu$
- ◆ It is easy to see nitrate is a spectator ion

Activity series chart

Activity Series Chart

Metals		Non-Metals	
Name	Symbol	Name	Symbol
Lithium	Li	Fluorine	F
Potassium	K	Chlorine	Cl
Barium	Ba	Bromine	Br
Strontium	Sr	Iodine	I
Calcium	Ca		
Sodium	Na		
Magnesium	Mg		
Aluminum	Al		
Manganese	Mn		
Zinc	Zn		
Iron	Fe		
Cadmium	Cd		
Cobalt	Co		
Nickel	Ni		
Tin	Sn		
Lead	Pb		
Hydrogen	H		
Copper	Cu		
Silver	Ag		
Mercury	Hg		
Gold	Au		

Elements **CANNOT** replace anything **ABOVE** them. The reaction **DOES NOT OCCUR** in this situation.

From the chart

- ◆ $Mg \rightarrow Mg^{2+} + 2 e^- \quad E = 2.37V$ (flipped)
- ◆ $Cu^{2+} + 2 e^- \rightarrow Cu \quad E = 0.34 V$
- ◆ $E_{cell} = 2.71 V$
- ◆ E is positive so the reaction does occur
- ◆ The net ionic equation of the cell is
- ◆ $Mg + Cu^{2+} \rightarrow Cu + Mg^{2+}$

Old chart from test

STANDARD REDUCTION POTENTIALS IN AQUEOUS SOLUTION AT 25°C

Half reaction	E°(V)
$Li^+ + e^- \rightarrow Li(s)$	-3.05
$Cs^+ + e^- \rightarrow Cs(s)$	-2.92
$K^+ + e^- \rightarrow K(s)$	-2.92
$Rb^+ + e^- \rightarrow Rb(s)$	-2.92
$Ba^{2+} + 2 e^- \rightarrow Ba(s)$	-2.90
$Sr^{2+} + 2 e^- \rightarrow Sr(s)$	-2.89
$Ca^{2+} + 2 e^- \rightarrow Ca(s)$	-2.87
$Na^+ + e^- \rightarrow Na(s)$	-2.71
$Mg^{2+} + 2 e^- \rightarrow Mg(s)$	-2.37
$Be^{2+} + 2 e^- \rightarrow Be(s)$	-1.90
$Al^{3+} + 3 e^- \rightarrow Al(s)$	-1.66
$Mn^{2+} + 2 e^- \rightarrow Mn(s)$	-1.18
$Zn^{2+} + 2 e^- \rightarrow Zn(s)$	-0.76
$Cr^{3+} + 3 e^- \rightarrow Cr(s)$	-0.74
$Pb^{2+} + 2 e^- \rightarrow Pb(s)$	-0.44
$Cu^{2+} + e^- \rightarrow Cu^+(aq)$	-0.41
$Cd^{2+} + 2 e^- \rightarrow Cd(s)$	-0.40
$Tl^+ + e^- \rightarrow Tl(s)$	-0.34
$Cu^+ + 2 e^- \rightarrow Cu(s)$	-0.28
$Ni^{2+} + 2 e^- \rightarrow Ni(s)$	-0.25
$Sn^{2+} + 2 e^- \rightarrow Sn(s)$	-0.14
$Pb^{2+} + 2 e^- \rightarrow Pb(s)$	-0.13
$2 H^+ + 2 e^- \rightarrow H_2(g)$	0.00
$Sr(s) + 2 H^+ + 2 e^- \rightarrow H_2S(g)$	0.14
$Sn^{4+} + 2 e^- \rightarrow Sn^{2+}$	0.15
$Cu^+ + e^- \rightarrow Cu^0$	0.15
$Cu^{3+} + 2 e^- \rightarrow Cu^{2+}$	0.34
$Cu^+ + e^- \rightarrow Cu(s)$	0.52
$I_2(aq) + 2 e^- \rightarrow 2 I^-$	0.53

Examples

- ◆ Zinc is added to a solution of cobalt (II) chloride
- ◆ Cadmium is added to a solution of barium iodide
- ◆ Lithium is added to a solution of copper (II) chloride forming a precipitate
- ◆ Chromium is left in water

Examples

- ◆ Potassium is added to sulfuric acid
- ◆ Silver is added to hydrochloric acid
- ◆ Chlorine gas is bubbled through a solution of sodium bromide

Other soluble compounds

- ◆ All **acetates** are soluble except Fe^{3+}
- ◆ All **chlorates** are soluble.
- ◆ All binary compounds of the **halogens** (other than F) with metals are soluble, except those of Silver, Mercury(I), and Lead. **Fluorides** are insoluble except for rule 1 and 2.
- ◆ All **sulfates** are soluble, except those of barium, strontium, calcium, lead, silver, and mercury (I).

Chapter 9 Double replacement reactions

- ◆ $\text{AY} + \text{BX} \rightarrow \text{AX} + \text{BY}$
- ◆ These reactions occur in solution
- ◆ Remember in solution the ions are free floating. For a reaction to occur, the ions have to come together and leave their dissolved state.
- ◆ Formation of a precipitate
- ◆ Formation of a gas
- ◆ Formation of a molecular species

Insoluble compounds

- ◆ **Carbonates, oxalates, sulfites, chromates, oxides, silicates, and phosphates** are insoluble.
- ◆ **Hydroxides** are insoluble except Ba, Sr, and Ca
- ◆ **Sulfides** are insoluble except for calcium, barium, strontium, magnesium.
- ◆ **The exception is with alkali metals or ammonium.**

Solubility Rules

- ◆ Acids are soluble.
- ◆ Compounds of: alkali metals, ammonium, and nitrate are soluble.
- ◆ This needs to be memorized.

Ch 10 Net Ionic Equation

- ◆ Determine what dissolved and precipitated
 - ◆ $\text{Mg}(\text{NO}_3)_2(\text{aq}) + \text{Na}_2\text{CO}_3(\text{aq}) \rightarrow \text{MgCO}_3(\text{s}) + 2\text{NaNO}_3(\text{aq})$
 - ◆ Dissociate everything that is aqueous, not solid
 - ◆ $\text{Mg}^{++} + \cancel{2\text{NO}_3^-} + \cancel{2\text{Na}^+} + \text{CO}_3^{--}$
 $\rightarrow \text{MgCO}_3(\text{s}) + \cancel{2\text{Na}^+} + \cancel{2\text{NO}_3^-}$
 - ◆ Now cancel out everything that is the same on both sides of the equation
 - ◆ These are called **spectator ions**. The remaining part is the net ionic equation
- $$\text{Mg}^{++} + \text{CO}_3^{--} \rightarrow \text{MgCO}_3(\text{s})$$

Examples

- ◆ Hydrochloric acid reacts with silver nitrate
- ◆ Potassium carbonate reacts with calcium chloride
- ◆ Sodium chloride reacts with ammonium oxalate
- ◆ Scandium acetate reacts with lithium chromate

Gases

- ◆ H_2S (hydrogen sulfide) is formed from any sulfide reacting with an acid
- ◆ CO_2 (Carbon dioxide) is formed from any carbonate reacting with an acid, water is also produced
- ◆ SO_2 (sulfur dioxide) is formed from any sulfite reacting with an acid, water is also produced
- ◆ NH_3 (ammonia) is formed from ammonium reacting with a soluble hydroxide

Examples

- ◆ Ammonium chloride reacts with calcium hydroxide
- ◆ Sodium sulfide is combined with nitric acid
- ◆ Ammonium carbonate is combined with barium chlorate
- ◆ Lithium sulfite reacts with phosphoric acid