Reactivity of Metals

The Reactivity Series:

- By doing experiments scientists have ranked the reactivity of many metals and their ions.

- The more reactive a metal is, the less reactive its ion is.

Activity Series for 1.0 mol/L Solution at 25 °C and 101.325 kPa

Very reactive ion

Very stable atom

Reduction Half-Reaction				
$Au^{3+}(aq)$	+	$3e^-$	→	$Au(s)$
$Hg^{2+}(aq)$	+	$2e^-$	→	$Hg(l)$

So any reaction with Au^{3+} will most likely go ⇒

$2H^+(aq)$	+	$2e^-$	→	$H_2(g)$
$Pb^{2+}(aq)$	+	$2e^-$	→	$Pb(s)$
$Sn^{2+}(aq)$	+	$2e^-$	→	$Sn(s)$
$Ni^{2+}(aq)$	+	$2e^-$	→	$Ni(s)$
$Cd^{2+}(aq)$	+	$2e^-$	→	$Cd(s)$
$Fe^{2+}(aq)$	+	$2e^-$	→	$Fe(s)$
$Zn^{2+}(aq)$	+	$2e^-$	→	$Zn(s)$
$Cr^{2+}(aq)$	+	$2e^-$	→	$Cr(s)$
$Al^{3+}(aq)$	+	$3e^-$	→	$Al(s)$
$Mg^{2+}(aq)$	+	$2e^-$	→	$Mg(s)$

strength of reactant as an oxidizing

ig strength of reactant as a reducing

So a reaction involving Li will most likely go

Very stable ion

Incre

$Ca^{2+}(aq)$	+	$2e^-$	→	$Ca(s)$
$Li^+(aq)$	+	e^-	→	$Li(s)$

Very reactive atom

- Au^{3+} is on the top left of the table which means it is very reactive
- Au^{3+} is easily reduced to Au metal
- Au^{3+} is a very strong oxidizing agent
- Au metal is not easily oxidized to the ion (gold doesn’t react with many substances)

- When you read the table from left to right, it is a reduction reaction

- From right to left, it is an oxidation reaction

Increasing strength of reactant as an oxidizing agent (↑)

Reduction Half-Reaction				
$Au^{3+}(aq)$	+	$3e^-$	→	$Au(s)$
$Hg^{2+}(aq)$	+	$2e^-$	→	$Hg(l)$
$Ag^+(aq)$	+	e^-	→	$Ag(s)$
$Cu^{2+}(aq)$	+	$2e^-$	→	$Cu(s)$
$2H^+(aq)$	+	$2e^-$	→	$H_2(g)$
$Pb^{2+}(aq)$	+	$2e^-$	→	$Pb(s)$
$Sn^{2+}(aq)$	+	$2e^-$	→	$Sn(s)$
$Ni^{2+}(aq)$	+	$2e^-$	→	$Ni(s)$
$Cd^{2+}(aq)$	+	$2e^-$	→	$Cd(s)$
$Fe^{2+}(aq)$	+	$2e^-$	→	$Fe(s)$
$Zn^{2+}(aq)$	+	$2e^-$	→	$Zn(s)$
$Cr^{2+}(aq)$	+	$2e^-$	→	$Cr(s)$
$Al^{3+}(aq)$	+	$3e^-$	→	$Al(s)$
$Mg^{2+}(aq)$	+	$2e^-$	→	$Mg(s)$
$Na^+(aq)$	+	e^-	→	$Na(s)$
$Ca^{2+}(aq)$	+	$2e^-$	→	$Ca(s)$
$Li^+(aq)$	+	e^-	→	$Li(s)$

Increasing strength of reactant as a reducing agent (↓)

- You can use the Activity Series to predict if whether on not a spontaneous reaction will occur. (i.e. a reaction that occurs on its own with no extra energy added.)

Example

A piece of zinc is added to a solution of copper(II) nitrate. Will a reaction occur?

$Zn(s) + Cu(NO_3)_{2(aq)} \rightarrow Zn(NO_3)_{2(aq)} + Cu_{(s)}$

atom Cu^{2+} ion Zn^{2+} atom

- Write the possible reduction ½ reactions

$Zn^{2+} + 2e^- \rightarrow Zn$

$Cu^{2+} + 2e^- \rightarrow Cu$

- Cu^{2+} is near the top left which means Cu^{2+} is very reactive and Cu atoms are stable
- Zn(s) atoms are near bottom right which means that Zn atoms are reactive and Zn^{2+} ions are stable

Reduction Half-Reaction				
$Au^{3+}(aq)$	+	$3e^-$	→	Au(s)
$Hg^{2+}(aq)$	+	$2e^-$	→	Hg(l)
$Ag^{+}(aq)$	+	e^-	→	Ag(s)
$Cu^{2+}(aq)$	+	$2e^-$	→	Cu(s)
$2H^{+}(aq)$	+	$2e^-$	→	$H_2(g)$
$Pb^{2+}(aq)$	+	$2e^-$	→	Pb(s)
$Sn^{2+}(aq)$	+	$2e^-$	→	Sn(s)
$Ni^{2+}(aq)$	+	$2e^-$	→	Ni(s)
$Cd^{2+}(aq)$	+	$2e^-$	→	Cd(s)
$Fe^{2+}(aq)$	+	$2e^-$	→	Fe(s)
$Zn^{2+}(aq)$	+	$2e^-$	→	Zn(s)
$Cr^{2+}(aq)$	+	$2e^-$	→	Cr(s)

- Whenever the reduction ½ reaction is above the oxidizing ½ reaction, the reaction is spontaneous

Homework

- P 82: #28, 29
- P83: #31, 32