Identify the chemical that is oxidized, the one that is reduced and the oxidizing agent and reducing agent.

red Ox

$Hg^{2+} + Mn \rightarrow Hg + Mn^{2+}$

OA RA

R O

$Br_2 + 2Cr^{3+} \rightarrow 2Br^- + 2Cr^{3+}$

OA RA

Determine the oxidation numbers for each element:

2- 1+

N_2H_4

Al_2O_3 2-

3+

ClO_3^-

5+ 2-

$Cu + AgNO_2$

$Cu + Ag^+ \rightarrow Cu^{2+} + Ag$

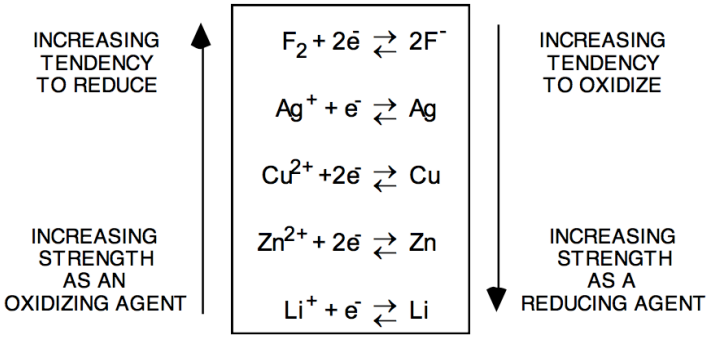
O R

$(e^- + Ag^+ \rightarrow Ag^0)2$

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

Predicting Spontaneous Reactions

The last page of your Chem12 Data Booklet is the Table of Reduction Potentials.



Here are some observations of the Table:

1. In general, metals (exceptions Cu, Ag, Hg & Au) are found on the bottom right half (reducing agents).
2. In general halogens and oxyanions (oxygen containing anions) are found in the upper left half (oxidizing agents).
3. Some metals such as Fe, Sn, Cr, Hg & Cu have > 1 common oxidation number and therefore > 2 half-reaction.
4. Some ions (Cu^+, Sn^{2+}, Fe^{2+}) appear on both sides of the table and can behave as oxidizing agents or reducing agents.

e.g. $\boxed{Cu^+} + e^- \rightleftarrows Cu(s)$

$Cu^{2+} + 2e- \rightleftarrows Cu(s)$

$Cu^{2+} + e^- \rightleftarrows \boxed{Cu^+}$

5. H_2O_2 can be an oxidizing agent or a reducing agent.

oxidizing agents gain electrons & tend to be **cations** (+) or **non-metals**

reducing agents lose electrons & tend to be **anions** (-) or **metals**

- **stronger oxidizing agents** are located on the **upper left** and have a greater tendency to gain electrons (reduce)
- **stronger reducing agents** are located on the **lower right** and have a greater tendency to lose electrons (oxidize)

Consider the half-reaction for Zn and Zn^{2+}:

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

Zn^{2+} is an oxidizing agent and will gain electrons:

$$Zn^{2+} + 2e^- \rightarrow Zn \text{ (reduction)}$$

Zn is a reducing agent and will lose electrons:

$$Zn \rightarrow Zn^{2+} + 2e^- \text{ (oxidation)}$$

Note: When referring to an isolated half-reaction, use equilibrium arrows to show that the reaction can go forward or backward.

$$Ag^+ + e^- \rightleftarrows Ag$$

If the half-reaction is made to undergo either reduction or oxidation as a result of being part of a redox reaction, use a one-way arrow.

$$Ag^+ + e^- \rightarrow Ag$$

Spontaneous reactions will occur when there is:

an oxidizing agent (reduction) and a reducing agent (oxidation)

and

the oxidizing agent must be above the reducing agent in the table

ex. Which of the following metals - Al, Pb, Cu, Fe and Ag - can be oxidized by Cr^{3+}?

$3e^- + Cr^{3+} \rightarrow Cr$

OA

RA

Al, Fe } spontaneous

ex. Predict whether a spontaneous reaction is expected and the products that would be formed.

a) Pb^{2+} and MnO_2

OA RA

not spontaneous

b) $Cr_2O_7^{2-}$ and Sn^{2+}

OA RA

spontaneous

RED $Cr_2O_7^{2-} + 14H^+ + 6e^- \rightarrow 2Cr^{3+} + 7H_2O$

Ox $3(Sn^{2+} \rightarrow Sn^{4+} + 2e^-)$

Overall $Cr_2O_7^{2-} + 14H^+ + 3Sn^{2+} \rightarrow 3Sn^{4+} + 2Cr^{3+} + 7H_2O$

ex. Consider the following spontaneous redox reactions:

$$X + Y \rightarrow X^- + Y^+$$
$$Y^+ + Z \rightarrow Y + Z^+$$
$$Z + X \rightarrow Z^+ + X^-$$

What is the relative strengths of oxidizing agents (strongest to weakest)?

$X \rightarrow X^-$

$Y^+ \leftarrow Y$

$Z^+ \leftarrow Z$

$X > Y^+ > Z^+$

ex. A solution containing Pd^{2+} reacts spontaneously with Ga to produce Pd and Ga^{3+}. However, a solution containing Pd^{2+} does not react with Pt. What are the reducing agents in order of increasing strengths?

Spont. $Pd^{2+} + Ga \rightarrow Pd + Ga^{3+}$

OA RA RA OX

$Pd^{2+} + Pt \not\rightarrow$

OA RA

$GA > Pd > Pt$