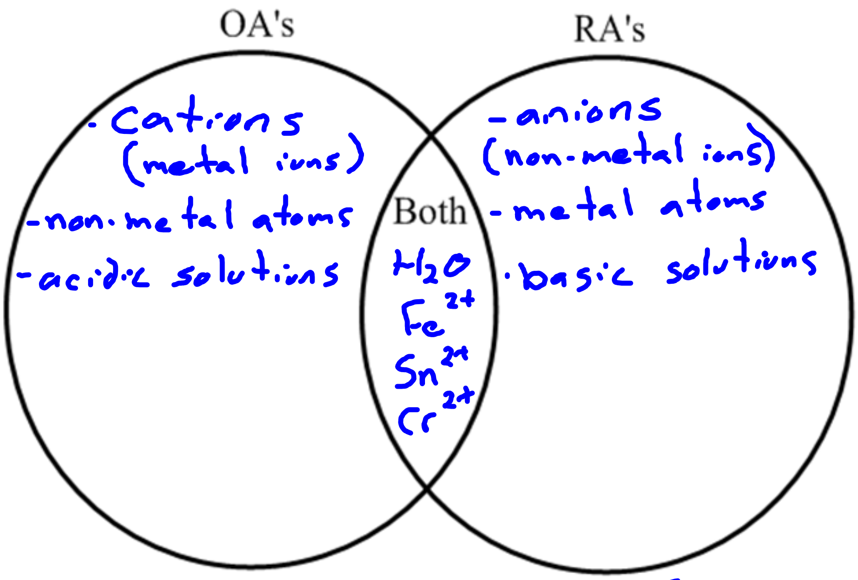
Some generalizations can be made about what type of entities are OA's, RA's, or can be both.



$$Fe^{3+} \longleftarrow Fe^{2+} \longrightarrow Fe_{(s)}$$

$$Sn^{4+} \longleftarrow Sn^{2+} \longrightarrow Sn_{(s)}$$

Your Redox Table

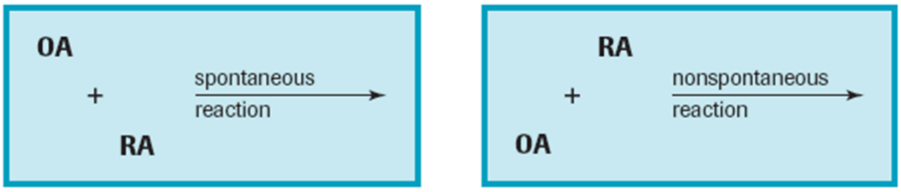
There is a larger redox table made from the data of hundreds of experiments done over time found on pg 7 of your data booklet.

Table of Selected Standard Electrode Potentials*

Reduction Half-Reaction	Electrical Potential $E°$ (V)
$F_2(g) + 2e^- \rightleftharpoons 2F^-(aq)$	+2.87
$PbO_2(s) + SO_4^{2-}(aq) + 4H^+(aq) + 2e^- \rightleftharpoons PbSO_4(s) + 2H_2O(l)$	+1.69
$MnO_4^-(aq) + 8H^+(aq) + 5e^- \rightleftharpoons Mn^{2+}(aq) + 4H_2O(l)$	+1.51
$Au^{3+}(aq) + 3e^- \rightleftharpoons Au(s)$	+1.50
$ClO_4^-(aq) + 8H^+(aq) + 8e^- \rightleftharpoons Cl^-(aq) + 4H_2O(l)$	+1.39
$Cl_2(g) + 2e^- \rightleftharpoons 2Cl^-(aq)$	+1.36
$2HNO_2(aq) + 4H^+(aq) + 4e^- \rightleftharpoons N_2O(g) + 3H_2O(l)$	+1.30
$Cr_2O_7^{2-}(aq) + 14H^+(aq) + 6e^- \rightleftharpoons 2Cr^{3+}(aq) + 7H_2O(l)$	+1.23
$O_2(g) + 4H^+(aq) + 4e^- \rightleftharpoons 2H_2O(l)$	+1.23
$MnO_2(s) + 4H^+(aq) + 2e^- \rightleftharpoons Mn^{2+}(aq) + 2H_2O(l)$	+1.22
$Br_2(l) + 2e^- \rightleftharpoons 2Br^-(aq)$	+1.07
$Hg^{2+}(aq) + 2e^- \rightleftharpoons Hg(l)$	+0.85
$OCl^-(aq) + H_2O(l) + 2e^- \rightleftharpoons Cl^-(aq) + 2OH^-(aq)$	+0.84
$2NO_3^-(aq) + 4H^+(aq) + 2e^- \rightleftharpoons N_2O_4(g) + 2H_2O(l)$	+0.80
$Ag^+(aq) + e^- \rightleftharpoons Ag(s)$	+0.80
$Fe^{3+}(aq) + e^- \rightleftharpoons Fe^{2+}(aq)$	+0.77
$O_2(g) + 2H^+(aq) + 2e^- \rightleftharpoons H_2O_2(l)$	+0.70
$I_2(s) + 2e^- \rightleftharpoons 2I^-(aq)$	+0.54
$O_2(g) + 2H_2O(l) + 4e^- \rightleftharpoons 4OH^-(aq)$	+0.40
$Cu^{2+}(aq) + 2e^- \rightleftharpoons Cu(s)$	+0.34
$SO_4^{2-}(aq) + 4H^+(aq) + 2e^- \rightleftharpoons H_2SO_3(aq) + H_2O(l)$	+0.17
$Sn^{4+}(aq) + 2e^- \rightleftharpoons Sn^{2+}(aq)$	+0.15
$S(s) + 2H^+(aq) + 2e^- \rightleftharpoons H_2S(aq)$	+0.14

The Spontaneity Rule

The redox spontaneity rule states that a spontaneous redox reaction occurs only if the oxidizing agent (OA) is above the reducing agent (RA) in a table of relative strengths of oxidizing and reducing agents



Predict if a reaction will occur between the following reactants:

a. solid lead and flourine gas

$Pb_{(s)}$ $F_{2(g)}$

b. solid zinc and water

$Zn_{(s)}$ $H_2O_{(l)}$

c. silver ions and solid tin

$Ag^+_{(aq)}$ $Sn_{(s)}$

The spontaneity rule gives us another way of creating a redox table

OA RA

$3\ Co^{2+}(aq) + 2\ In(s) \rightarrow 2\ In^{3+}(aq) + 3\ Co(s)$ (spontaneous)

OA RA

$Cu^{2+}(aq) + Co(s) \rightarrow Co^{2+}(aq) + Cu(s)$ (spontaneous)

OA RA

$Cu^{2+}(aq) + Pd(s) \rightarrow$ no evidence of reaction (nonspontaneous)

$Pd^{2+} + 2e^- \rightleftharpoons Pd_{(s)}$

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

$Co^{2+} + 2e^- \rightleftharpoons Co_{(s)}$

$In^{3+} + 3e^- \rightleftharpoons In_{(s)}$

10. An experiment similar to the example of metals and metal ions was conducted using halogens and halide ions. Prepare a redox table of half-reaction equations similar to **Table 3** for the halogens.

Evidence

Only three combinations produced evidence of a reaction (**Figure 4**, **Table 4**).

Table 4 Reactions of Halogens with Solutions of Halides

OA

RA

	$Br_2(aq)$	$Cl_2(aq)$	$I_2(aq)$
$Br^-(aq)$	no reaction	yellow-brown	no reaction
$Cl^-(aq)$	no reaction	no reaction	no reaction
$I^-(aq)$	pink/purple	pink/purple	no reaction

$Cl_2 + 2e^- \rightarrow 2Cl^-$

$Br_2 + 2e^- \rightarrow 2Br^-$

$I_2 + 2e^- \rightarrow 2I^-$

A student performed the following reactions. Construct a table of relative strengths of oxidizing and reducing agents.

OA RA

$Co^{2+}(aq) + Zn(s) \rightarrow Co(s) + Zn^{2+}(aq)$

$Mg^{2+}(aq) + Zn(s) \rightarrow$ no evidence of reaction

OA RA

$Co^{2+}_{(aq)} + 2e^- \rightleftharpoons Co_{(s)}$

$Zn^{2+}_{(aq)} + 2e^- \rightleftharpoons Zn_{(s)}$

$Mg^{2+}_{(aq)} + 2e^- \rightleftharpoons Mg_{(s)}$

In a school laboratory, four metals were combined with each of four solutions and the following reactions occurred:

RA OA

$Be(s) + Cd^{2+}(aq) \rightarrow Be^{2+}(aq) + Cd(s)$

RA OA

$Cd(s) + 2\,H^+(aq) \rightarrow Cd^{2+}(aq) + H_2(g)$

OA RA

$Ca^{2+}(aq) + Be(s) \rightarrow$ no evidence of reaction

RA OA

$Cu(s) + H^+(aq) \rightarrow$ no evidence of reaction

Construct a table of relative strengths of oxidizing and reducing agents.

$Cu^{2+}_{(aq)} + 2e \rightleftharpoons Cu_{(s)}$

$2H^+_{(aq)} + 2e^- \rightleftharpoons H_{2(g)}$

$Cd^{2+}_{(aq)} + 2e^- \rightleftharpoons Cd_{(s)}$

$Be^{2+}_{(aq)} + 2e^- \rightleftharpoons Be_{(s)}$

$Ca^{2+}_{(aq)} + 2e^- \rightleftharpoons Ca_{(s)}$

Use the relative strengths of nonmetals and metals as oxidizing and reducing agents, as indicated in the following unbalanced equations, to construct a table of half-reactions.

$Ag^+ + Br^-$

$Ag(s) + Br_2(l) \rightarrow \overline{AgBr(s)}$

RA $Ag(s) + I_2(s) \rightarrow$ no evidence of reaction

OA $Cu^{2+}(aq) + I^-(aq) \rightarrow$ no redox reaction

$Br_2(l) + Cl^-(aq) \rightarrow$ no evidence of reaction

OA RA

$Cl_2 + 2e^- \rightleftharpoons 2Cl^-$

$Br_2 + 2e^- \rightleftharpoons 2Br^-$

$Ag^+ + 1e^- \rightleftharpoons Ag$

$I_2 + 2e \rightleftharpoons 2I^-$

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

Table 5 Reactions of Metals and Nonmetals with Solutions of Ions

	$I_2(aq)$	$Cu^{2+}(aq)$ OA	$Ag^+(aq)$	$Br_2(aq)$
$I^-(aq)$	X	X	✓	✓
Cu(s)	✓	X	✓	✓
RA Ag(s)	X	X	X	✓
$Br^-(aq)$	X	X	X	X

X no evidence of a redox reaction
✓ evidence redox reaction occurred

$Br_{2(aq)} + 2e \rightleftharpoons 2Br^-_{(aq)}$

$Ag^+_{(aq)} + 1e^- \rightleftharpoons Ag_{(s)}$

$I_{2(aq)} + 2e^- \rightleftharpoons 2I^-_{(aq)}$

$Cu^{2+}_{(aq)} + 2e^- \rightleftharpoons Cu_{(s)}$

Prepare a redox table showing the relative strengths of oxidizing and reducing agents in **Table 7**.

Table 7 Reactions of Group 13 Elements and Ions

	$Al^{3+}(aq)$	$Tl^+(aq)$ OA	$Ga^{3+}(aq)$	$In^{3+}(aq)$
Al	X	✓	✓	✓
Tl	X	X	X	X
RA Ga	X	✓	X	✓
In	X	✓	X	X

X no evidence of a redox reaction ✓ a spontaneous reaction

$Tl^+_{(aq)} + 1e^- \rightleftharpoons Tl_{(s)}$

$In^{3+}_{(aq)} + 3e^- \rightleftharpoons In_{(s)}$

$Ga^{3+}_{(aq)} + 3e^- \rightleftharpoons Ga_{(s)}$

$Al^{3+}_{(aq)} + 3e^- \rightleftharpoons Al_{(s)}$