Chemistry 12

Electrochemistry III

Name: Notes
Date:
Block:

1. SRP Table

Standard Reduction Potential (SRP) Table

Similarly to BL-acids and bases, oxidizing and reducing agents vary in strengths as well.

Oxidizing Agents are REDUCED. ~ gain e⁻

Its potential to be reduced is called its reduction potential.

The table is read left to right.

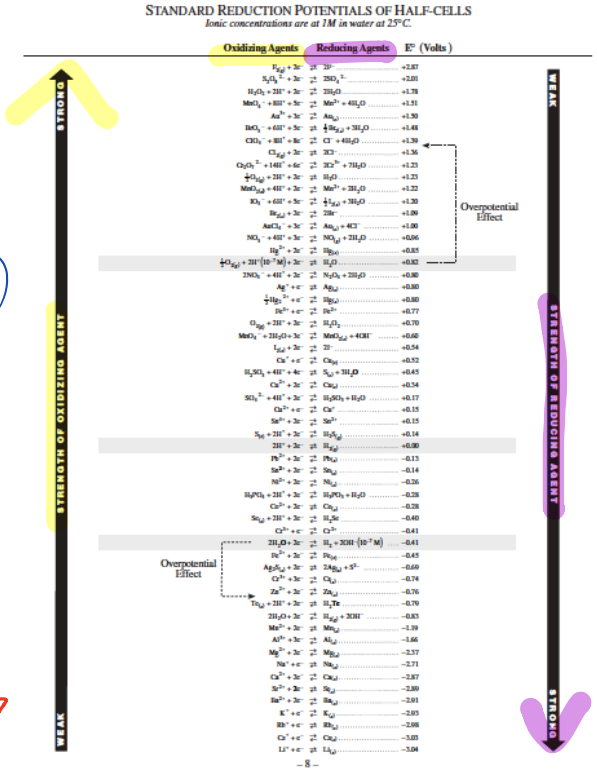
$F_{2(g)} + 2e^- \rightleftarrows 2F^-$ ..... +2.87

Reducing Agents are OXIDIZED. ~ lose e⁻

Its potential to be oxidized is called its oxidizing potential.

The table is read right to left.

$F_{2(g)} + 2e^- \rightleftarrows 2F^-$ ..... ~~+2.87~~ -2.87



Example:

lowest on right

highest on left

(strongest OA)

(strongest RA)

Strongest Reducing Agent:	Co	Sr	Al
Strongest Oxidizing Agent:	Fe^{3+}	Cu^{+}	Na^{+}
Greatest Reduction Potential:	Br^-	I^-	Sn^{4+}
Values:	N/A	N/A	+0.15V
Greatest Oxidation Potential:	Cr^{3+}	Pb	Hg
Values:	N/A	+0.13V	-0.80V

flipped!

Consider the following (unbalanced) redox reaction

$$Ag^+ + Al \rightarrow Ag + Al^{3+}$$

- Identify (and balance) the two half reactions:

$\times 3$ $\quad 3e^- + 3Ag^+ \rightarrow 3Ag$ $\quad E^\circ = +0.80V$

$Al \rightarrow Al^{3+} + 3e^-$ $\quad E^\circ = +1.66V$

$\times 3$

  - ✓ *Note 1: Since "voltage" is the work done per electron, do not multiple the E° value for the reduction of Ag⁺ by 3.*
  - ✓ *Note 2: If a half-reaction is reversed, the sign of its E° value is also reversed.*

- What is the total cell potential? Is it spontaneous?

$+ \; E^\circ_{total}$

$3Ag^+ + Al \rightarrow 3Ag + Al^{3+}$ $\quad E^\circ_{total} = +0.80V + 1.66V = +2.46V$

Spontaneous

Spontaneous or non-spontaneous?

Br_2 and I^-	Br^- and I_2
Br_2 is a(n) Oxidizing agent. Half reaction: $Br_2 + 2e^- \rightarrow 2Br^-$ I- is a(n) reducing agent. Half reaction: $2I^- \rightarrow I_2 + 2e^-$ Which is higher on the table? OA is higher than RA = spont.	Br- is a(n) reducing agent. Half reaction: $2Br^- \rightarrow Br_2 + 2e^-$ I_2 is a(n) Oxidizing agent. Half reaction: $I_2 + 2e^- \rightarrow 2I^-$ Which is higher on the table? RA is higher than OA = nonspont.
$Br_{2(\ell)} + 2e^- \rightleftarrows 2Br^-$ ..... +1.09 $AuCl_4^- + 3e^- \rightleftarrows Au_{(s)} + 4Cl^-$ ..... +1.00 $O_3 + 4H^+ + 3e^- \rightleftarrows NO_{(g)} + 2H_2O$ ..... +0.96 $Hg^{2+} + 2e^- \rightleftarrows Hg_{(\ell)}$ ..... +0.85 $H^+(10^{-7}\ M) + 2e^- \rightleftarrows H_2O$ ..... +0.82 $O_3 + 4H^+ + 2e^- \rightleftarrows N_2O_4 + 2H_2O$ ..... +0.80 $Ag^+ + e^- \rightleftarrows Ag_{(s)}$ ..... +0.80 $\frac{1}{2}Hg_2^{2+} + e^- \rightleftarrows Hg_{(\ell)}$ ..... +0.80 $Fe^{3+} + e^- \rightleftarrows Fe^{2+}$ ..... +0.77 $O_{2(g)} + 2H^+ + 2e^- \rightleftarrows H_2O_2$ ..... +0.70 $MnO_4^- + 2H_2O + 3e^- \rightleftarrows MnO_{2(s)} + 4OH^-$ ..... +0.60 $I_{2(s)} + 2e^- \rightleftarrows 2I^-$ ..... +0.54	$Br_{2(\ell)} + 2e^- \rightleftarrows 2Br^-$ ..... +1.09 $AuCl_4^- + 3e^- \rightleftarrows Au_{(s)} + 4Cl^-$ ..... +1.00 $O_3 + 4H^+ + 3e^- \rightleftarrows NO_{(g)} + 2H_2O$ ..... +0.96 $Hg^{2+} + 2e^- \rightleftarrows Hg_{(\ell)}$ ..... +0.85 $H^+(10^{-7}\ M) + 2e^- \rightleftarrows H_2O$ ..... +0.82 $O_3 + 4H^+ + 2e^- \rightleftarrows N_2O_4 + 2H_2O$ ..... +0.80 $Ag^+ + e^- \rightleftarrows Ag_{(s)}$ ..... +0.80 $\frac{1}{2}Hg_2^{2+} + e^- \rightleftarrows Hg_{(\ell)}$ ..... +0.80 $Fe^{3+} + e^- \rightleftarrows Fe^{2+}$ ..... +0.77 $O_{2(g)} + 2H^+ + 2e^- \rightleftarrows H_2O_2$ ..... +0.70 $MnO_4^- + 2H_2O + 3e^- \rightleftarrows MnO_{2(s)} + 4OH^-$ ..... +0.60 $I_{2(s)} + 2e^- \rightleftarrows 2I^-$ ..... +0.54
Total Voltage: $1.09V + (-0.54V) = +$	Total Voltage: $-1.09 + 0.54 = -$
Spontaneous or non-spontaneous?	*Spontaneous or non-spontaneous?*

When there are **more than two** chemicals available to react, the SRP table is used to predict which species will react.

The predominant redox reaction will be between:

Strongest OA and Strongest RA

Practice:

1. What will the predominant redox reaction be with a mixture of Cl_2, Ag^+, Sn^{2+} and I^-?

Oxidizing Agents

Cl_2, Ag^+, Sn^{2+} $\quad Cl_2 + 2e^- \rightarrow 2Cl^- \quad +1.36\,V$

Reducing Agents

Sn^{2+}, I^- $\quad Sn^{2+} \rightarrow Sn^{4+} + 2e^- \quad -0.15\,V$ (flipped!)

$Cl_2 + Sn^{2+} \rightarrow 2Cl^- + Sn^{4+} \quad +1.21\,V$

Spont.

2. Sn^{4+}, Br^-, Zn^{2+} and Ag

Oxidizing Agents

Sn^{4+}, Zn^{2+} $\quad Sn^{4+} + 2e^- \rightarrow Sn^{2+} \quad +0.15\,V$

Reducing Agents

Br^-, Ag $\quad 2Ag \rightarrow 2Ag^+ + 2e^- \quad -0.80\,V$ (flipped)

$Sn^{4+} + 2Ag \rightarrow Sn^{2+} + 2Ag^+ \quad -0.65\,V$

non-spont.

3. $CuBr_2$ and Al

↳ Cu^{2+}, Br^-

OA: Cu^{2+}

RA: Br^-, Al

$3Cu^{2+} + 6e^- \rightarrow 3Cu \quad +0.34\,V$

$2Al \rightarrow 2Al^{3+} + 6e^- \quad +1.66\,V$

$3Cu^{2+} + 2Al \rightarrow 3Cu + 2Al^{3+} \quad +2.00\,V$

spont.

4. Na^+, Cu^+ and F^-

OA: Na^+, Cu^+

RA: Cu^+, F^-

$Cu^+ + e^- \rightarrow Cu$ $+0.52V$

$Cu^+ \rightarrow Cu^{2+} + e^-$ $-0.15V$

$2Cu^+ \rightarrow Cu + Cu^{2+}$ $+0.37V$

spont

5. Copper metal and bromine liquid in a solution of iron (III) iodide

Cu Br_2 Fe^{3+} I^-

OA: Br_2, Fe^{3+}

RA: Cu, I^-

$Br_2 + 2e^- \rightarrow Br^-$ $+1.09V$

$Cu \rightarrow Cu^{2+} + 2e^-$ $-0.34V$

$Br_2 + Cu \rightarrow Br^- + Cu^{2+}$ $+0.75V$

spont.

6. I_2 and CaF_2

Ca^{2+} F^-

OA: I_2, Ca^{2+}

RA: F^-

$I_2 + 2e^- \rightarrow I^-$ $+0.54V$

$2F^- \rightarrow F_2 + 2e^-$ $-2.87V$

$I_2 + 2F^- \rightarrow I^- + F_2$ $-2.33V$

non-spont.

7. Al, Fe^{2+} and Cu^{2+}

OA: Fe^{2+}, Cu^{2+}

RA: Fe^{2+}, Al

$3Cu^{2+} + 2e^- \rightarrow 3Cu$ $+0.34V$

$2Al \rightarrow 2Al^{3+} + 3e^-$ $+1.66V$

$3Cu^{2+} + 2Al \rightarrow 3Cu + 2Al^{3+}$ $+2.00V$

spont.

Na^+ Cl^-

8. Br_2 and NaCl

OA

Br_2 Na^+

RA

Cl^-

$Br_2 + 2e^- \rightarrow 2Br^-$ $+1.09V$

$2Cl^- \rightarrow Cl_2 + 2e^-$ $-1.36V$

$Br_2 + 2Cl^- \rightarrow 2Br^- + Cl_2$ $-0.27V$

non-spont.

9. Sn and Al^{3+}

OA

Al^{3+}

RA

Sn

$2Al^{3+} + 3e^- \rightarrow 2Al$ $-1.66V$

$3Sn \rightarrow 3Sn^{2+} + 6e^-$ $+0.14V$

$2Al^{3+} + 3Sn \rightarrow 2Al + 3Sn^{2+}$ $-1.52V$

Non spont.

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