Oxidation **Red**uction Reactions

(red-ox rxns)

objectives:

(#4-3) How do chemicals undergo an oxidation reduction reaction?

(#4-3a) I can identify if a reaction is oxidation/reduction

(#4- 3b) I can identify which species in a reaction is being oxidized or reduced.

(#4- 3c) I can balance a "simple" redox reaction. Simple: Non- oxygen based.

(#4-3d) I can determine the voltage of a redox reaction.

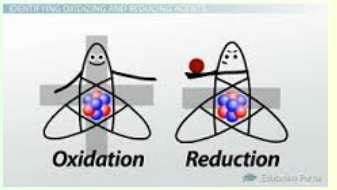
(#4-3e) I can determine the spontaneity based upon a chemical voltage.

also

I can write half reactions and model the reaction.

Oxidation **Red**uction Reactions

(a.k.a. **RedOx** rxns)



Atoms/ions gain and lose charge in reaction

- e^- are transfered from one species to another
- must occur simultaneously

First, must determine the oxidation state(charges)

oxidation state: the apparent charge on an atom

Oxidation State Rules

- 0 is alway 0^{-2} when bonded to other atom (except F)
- H is always H^{+I} when bonded to other atom (usually)
- elements by self have 0 charge if → not bonded; diatomic (super 7)
- use ion sheet or periodic table

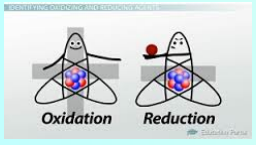
Practice: write oxidation state

Cu	O_2
$AgNO_3$	NO_2
Al	Fe
Cl_2	$FeCl_2$
HF	

try these:

SO_4^{-2}	$NaHCO_3$

Oxidation **Red**uction Reactions



(**redox** rxns)

Atoms/ions gain and lose charge in reaction

- e^- are transfered from one species to another
- must occur simultaneously

Lose **E**lectrons **O**xidation

Gain **E**lectrons **R**eduction

to help you remember

Check for REDOX: write charges (oxidation state) above each to see what happens to the charge.

Label Reduction and Oxidation.

$$Cu + AgNO_3 \rightarrow Cu(NO_3)_2 + Ag$$

Oxidation **Red**uction Reactions

(**redox** rxns)

Types: Determine oxidation and reduction

Metal Replaces Metal ion

$$Cu + AgNO_3 \rightarrow Cu(NO_3)_2 + Ag$$

Non-Metal Replaces NonMetal ion

$$NaCl + F_2 \rightarrow NaF + Cl_2$$

Combustion

$$CH_4 + O_2 \rightarrow$$

$$C_4H_8 + O_2 \rightarrow$$

Synthesis (often redox)

$$Na + Cl_2 \rightarrow NaCl$$

Decompostion (often redox

$$KClO_3 \rightarrow KCl + O_2$$

3 equations to depict reaction:

molecular, ionic and net ionic

molecular: $Cu + 2AgNO_3 \rightarrow Cu(NO_3)_2 + 2Ag$

ionic: $Cu^0 + 2Ag^{+1} + 2NO_3^{-1} \rightarrow Cu^{+2} + NO_3^{-1} + 2Ag^0$

(show any ions dissociated)

spectator ion: ion that does not change on either side and is not part of the reaction

(remove spectator ions -- cross off NO_3^{-1} -- same on both sides)

net ionic: $Cu^0 + 2Ag^{+1} \rightarrow Cu^{+2} + 2Ag^0$

actual chemical reaction

balancing 1/2 reactions

separate the species, add e^- to balance

lose e^- -- Ox. $Cu^0 \rightarrow Cu^{+2} + 2e^-$

gain e^- --Red. $2e^- + 2Ag^{+1} \rightarrow 2Ag^0$

net ionic: $Cu^0 + 2Ag^{+1} \rightarrow Cu^{+2} + 2Ag^0$

Does this reaction happen?

look at potential to lose or gain e^-

$Cu^0 \rightarrow Cu^{+2} + 2e^-$

$2e^- + 2Ag^{+1} \rightarrow 2Ag^0$

$Cu^0 + 2Ag^{+1} \rightarrow Cu^{+2} + 2Ag^0$

reduction potential chart: ability to gain e^- in E^0(Volts)

GER

(based off H_2 at 0 V)

Standard Reduction Potentials
in Aqueous Solution at 25°C

Half-reaction			$E°$(V)
$F_2(g) + 2e^-$	→	$2F^-$	2.87
$Co^{3+} + e^-$	→	Co^{2+}	1.82
$Au^{3+} + 3e^-$	→	$Au(s)$	1.50
$Cl_2(g) + 2e^-$	→	$2Cl^-$	1.36
$O_2(g) + 4H^+ + 4e^-$	→	$2H_2O(l)$	1.23
$Br_2(l) + 2e^-$	→	$2Br^-$	1.07
$2Hg^{2+} + 2e^-$	→	Hg_2^{2+}	0.92
$Hg^{2+} + 2e^-$	→	$Hg(l)$	0.85
$Ag^+ + e^-$	→	$Ag(s)$	0.80
$Hg_2^{2+} + 2e^-$	→	$2Hg(l)$	0.79
$Fe^{3+} + e^-$	→	Fe^{2+}	0.77
$I_2(s) + 2e^-$	→	$2I^-$	0.53
$Cu^+ + e^-$	→	$Cu(s)$	0.52
$Cu^{2+} + 2e^-$	→	$Cu(s)$	0.34
[illegible]	→	Cu^+	0.15
[illegible]	→	Sn^{2+}	0.15
[illegible]	→	$H_2S(g)$	0.14
$2H^+ + 2e^-$	→	$H_2(g)$	0.00
$Pb^{2+} + 2e^-$	→	$Pb(s)$	−0.13
$Sn^{2+} + 2e^-$	→	$Sn(s)$	−0.14
$Ni^{2+} + 2e^-$	→	$Ni(s)$	−0.25
$Co^{2+} + 2e^-$	→	$Co(s)$	−0.28
$Cd^{2+} + 2e^-$	→	$Cd(s)$	−0.40
$Cr^{3+} + e^-$	→	Cr^{2+}	−0.41
$Fe^{2+} + 2e^-$	→	$Fe(s)$	−0.44
$Cr^{3+} + 3e^-$	→	$Cr(s)$	−0.74
		$Zn(s)$	−0.76
		$H_2(g) + 2OH^-$	−0.83
		$Mn(s)$	−1.18
		$Al(s)$	−1.66
		$Be(s)$	−1.70
		$Mg(s)$	−2.37
		$Na(s)$	−2.71
		$Ca(s)$	−2.87
		$Sr(s)$	−2.89
		$Ba(s)$	−2.90
		$Rb(s)$	−2.92
		$K(s)$	−2.92
		$Cs(s)$	−2.92
		$Li(s)$	−3.05

compare rxn to find E^0

$2e^- + 2Ag^{+1} \rightarrow 2Ag^0$ **+0.80 V**

same rxn: use E^0

2x's e^-, but **do not** 2x's E^0

$Cu^0 \rightarrow Cu^{+2} + 2e^-$ **-0.34 V**

reverse rxn:

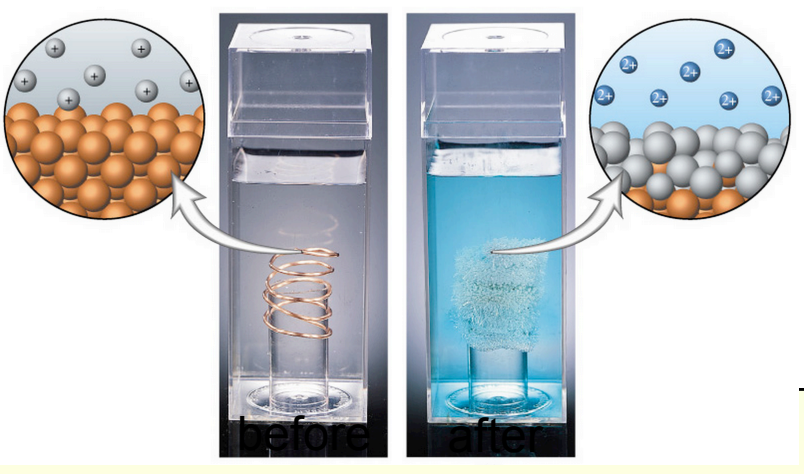
use E^0 with opposite sign

+0.46 V

spontaneous

+ V = rxn will occur

- V = rxn will not occur



Determine if Red-Ox, write ionic and net ionic eq.

remember to balance these

mol. $NaF_{(aq)} + Cl_{2(g)} \rightarrow NaCl_{(aq)} + F_2$

ionic: $Na^{+1} + F^{-1} + Cl_2^0 \rightarrow Na^{+1} + Cl^{-1} + F_2^0$

net ionic: $F^{-1} + Cl_2^0 \rightarrow Cl^{-1} + F_2^0$

GER

half reactions and E^0 (reduction potential)

$2F^{-1} \rightarrow F_2 + 2e^-$ -2.87

$2e^- + Cl_2 \rightarrow 2Cl^{-1}$ +1.36

$2F^{-1} + Cl_2 \rightarrow 2Cl^{-1} + F_2$ -1.51 V

E^0 (-) is non-spontaneous

does not occur without electric current

Predict products:

$$Zn^{0} + Cu^{+2}(SO_4)^{-1}{}_2 \rightarrow ?$$

Zn usually becomes Zn^{+2}

$Zn^0 \rightarrow Zn^{+2} + 2e^-$

Cu --either +1 or +2

$Cu^{+2} + 1e^- \rightarrow Cu^{+1}$

$Cu^{+2} + 2e^- \rightarrow Cu^0$

SO_4^{-1} spectator ion

general rule:
metals exchange with metals
non-metals exchange with non-metals

$Zn^0 + Cu^{+2} \rightarrow Zn^{+2} + Cu^0$

Does this happen?

Check reduction potential chart

$Cu^{+2} + 2e^- \rightarrow Cu^0$ +0.34 V

$Zn \rightarrow Zn^{+2} + 2e^-$ +0.76V

+1.00 V

V is (+) so spontaneous rxn

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$Hg^{2+} + 2e^-$	→	$Hg(l)$	0.85
$Ag^+ + e^-$	→	$Ag(s)$	0.80
$Hg_2^{2+} + 2e^-$	→	$2Hg(l)$	0.79
$Fe^{3+} + e^-$	→	Fe^{2+}	0.77
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$Cu^{2+} + 2e^-$	→	$Cu(s)$	0.34
$Cu^{2+} + e^-$	→	Cu^+	0.15
$Sn^{4+} + 2e^-$	→	Sn^{2+}	0.15
$S(s) + 2H^+ + 2e^-$	→	$H_2S(g)$	0.14
$2H^+ + 2e^-$	→	$H_2(g)$	0.00
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$Fe^{2+} + 2e^-$	→	$Fe(s)$	−0.44
$Cr^{3+} + 3e^-$	→	$Cr(s)$	−0.74
$Zn^{2+} + 2e^-$	→	$Zn(s)$	−0.76
$2H_2O(l) + 2e^-$	→	$H_2(g) + 2OH^-$	−0.83
		$Mn(s)$	−1.18
		$Al(s)$	−1.66
		$Be(s)$	−1.70
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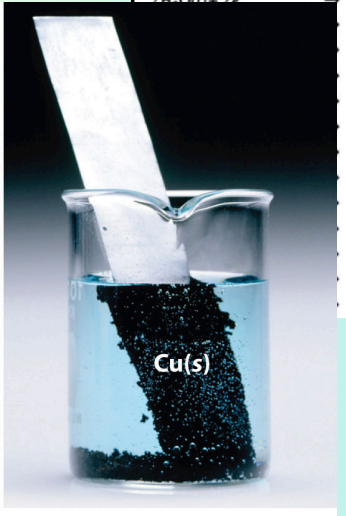


$Zn(s) + Cu^{2+}(aq) \rightarrow Zn^{2+}(aq) + Cu(s)$

$$KI + Br_2 \rightarrow$$

ionic $K^{+1} + I^{-1} + Br_2^0 \rightarrow K^{+1} + Br^{-1} + I_2^0$

net $I^{-1} + Br_2^0 \rightarrow Br^{-1} + I_2^0$

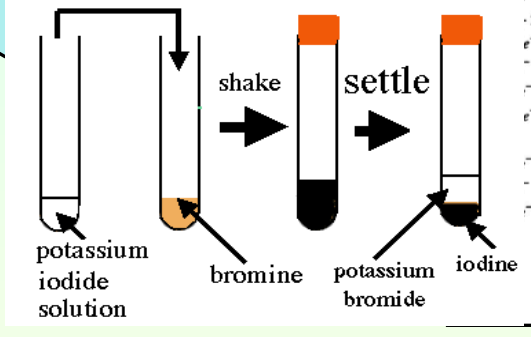
same rxn: use E^0
reverse rxn:
use E^0 with opposite sign

$2e^- + Br_2^0 \rightarrow 2Br^{-1}$ **+1.07**

$2\ I^{-1} \rightarrow I_2^0 + 2e^-$ **-0.53**

$2\ I^{-1} + Br_2^0 \rightarrow 2Br^{-1} + I_2^0$ **+0.54 V**

+ V = rxn will occur spontaneous



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$Sr^{2+} + 2e^-$	→	$Sr(s)$	−2.89
$Ba^{2+} + 2e^-$	→	$Ba(s)$	−2.90
$Rb^+ + e^-$	→	$Rb(s)$	−2.92
$K^+ + e^-$	→	$K(s)$	−2.92
$Cs^+ + e^-$	→	$Cs(s)$	−2.92
$Li^+ + e^-$	→	$Li(s)$	−3.05

Will the reverse (opposite) reaction occur?

$$KBr + I_2 \longrightarrow KI + Br_2$$

- 0.54V

- V so nonspontaneous

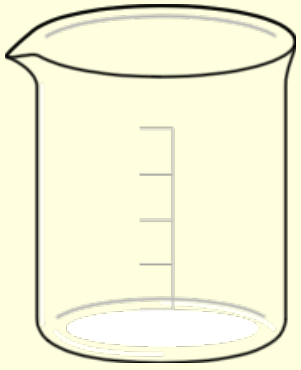
(reaction will not occur)

Write the molecular, ionic, and net ionic equation

Write the half reactions.

Determine the voltage and

if the reaction is spontaneous.



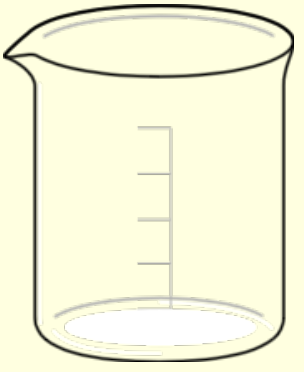
$Na + FeCl_2 \longrightarrow$

Write the molecular, ionic, and net ionic equation

Write the half reactions.

Determine the voltage and i

f the reaction is spontaneous.



$Cu + AgNO_3$

Write the molecular, ionic, and net ionic equation

Write the half reactions.

Determine the voltage and

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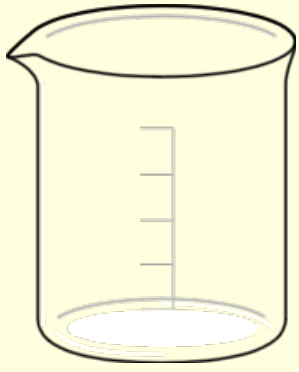

$Al + Zn(NO_3)_2$

Which will occur?

$$Al + Na_2SO_4 \longrightarrow Al_2(SO_4)_3 + Na$$

$$Al_2(SO_4)_3 + Na \longrightarrow Al + Na_2SO_4$$

Write the molecular, ionic, and net ionic equation

Write the half reactions.

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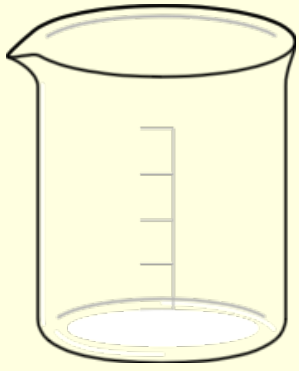

$$Ag + Au(N0_3)_3$$