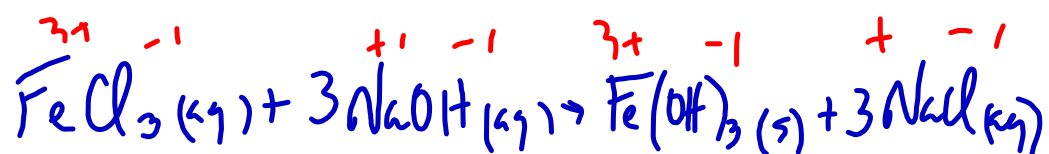


Is the following reaction a redox reaction?



double replacement rxn.



→ No reduction/oxidation.

## Synthesis of a Reaction Spontaneity Rule

Usually it is assumed that chemical rxns are spontaneous; that is, they occur without a continuous addition of energy to the system.

**Are all single replacement reactions spontaneous?**

Which combinations of copper, lead, silver and zinc metals and their aqueous metal ion solutions produce spontaneous reactions?  
(Nitrate solutions were used.)

ppt → precipitate

	Cu <sub>(s)</sub>	Pb <sub>(s)</sub>	Ag <sub>(s)</sub>	Zn <sub>(s)</sub>
Cu <sup>+2</sup> <sub>(aq)</sub>	no change	red-brown ppt	no change	red-brown ppt
Pb <sup>+2</sup> <sub>(aq)</sub>	no change	no change	no change	black ppt.
Ag <sup>+</sup> <sub>(aq)</sub>	silver crystals	silver crystals	no change	silver crystals
Zn <sup>+2</sup> <sub>(aq)</sub>	no change	no change	no change	no change

The reactivity of the four metal ions  
can be compared.

# of Rxns that occurred	3	2	1	0
Ions	$\text{Ag}^+(\text{aq})$	$\text{Cu}^{2+}(\text{aq})$	$\text{Pb}^{2+}(\text{aq})$	$\text{Zn}^{2+}(\text{aq})$

—————> decrease in reactivity  
of oxidizing agents

Ions → Oxidizing agents

# Rxns occurring metals	3	2	1	0
	$\text{Zn}(\text{s})$	$\text{Pb}(\text{s})$	$\text{Cu}(\text{s})$	$\text{Ag}(\text{s})$

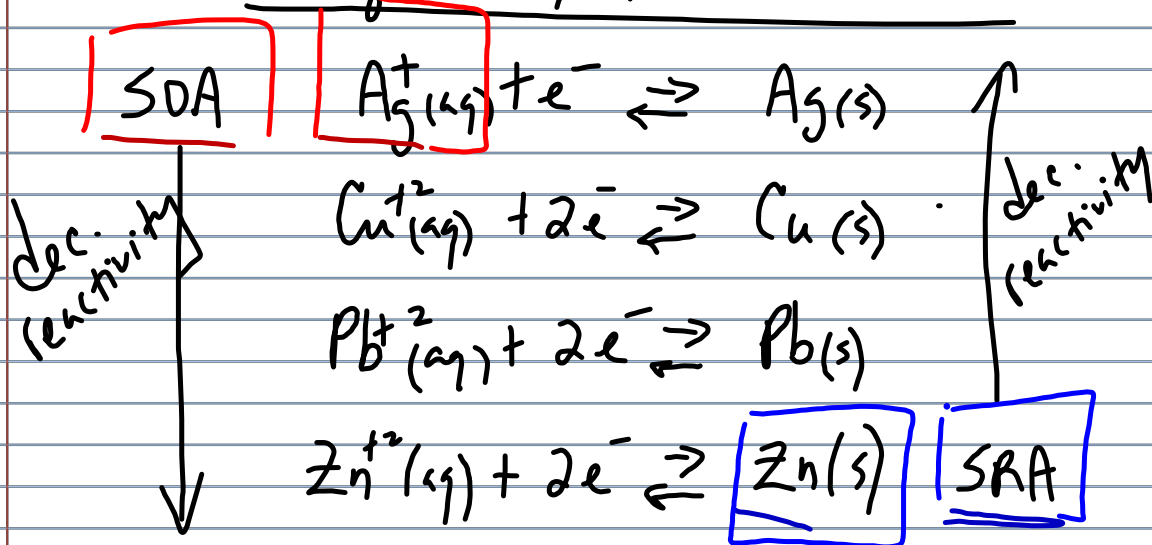
—————> decrease in reactivity  
of reducing agents.

Metals → Reducing agents

SOA → Strongest oxidizing agent →  $\text{Ag}^+(\text{aq})$

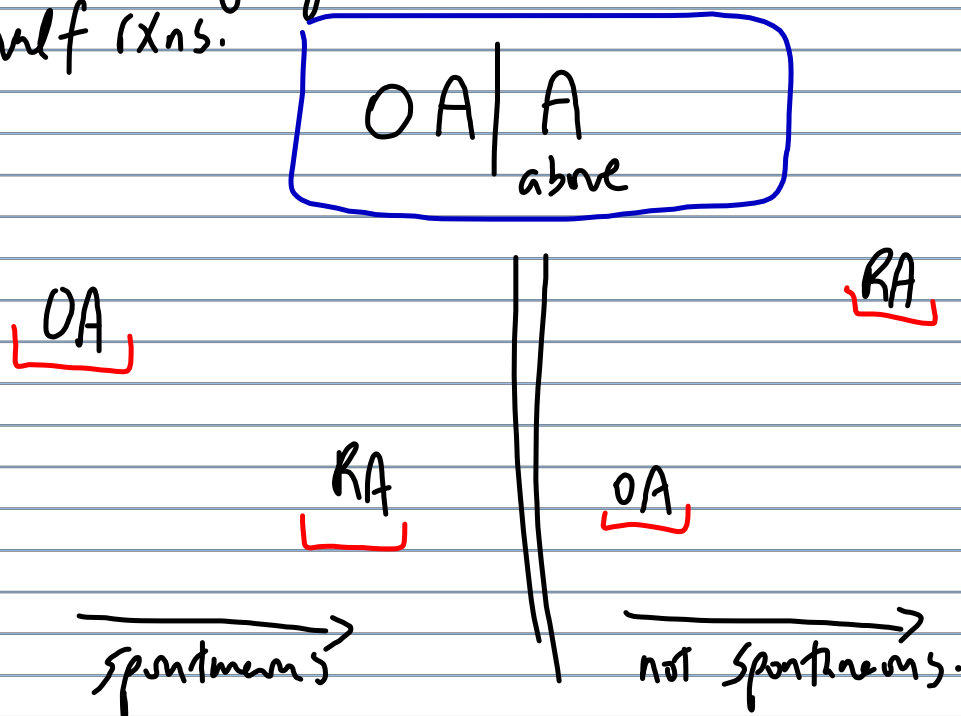
SRA → " Reducing agent →  $\text{Zn}(\text{s})$

## Table of Redox Half-Reactions $\rightleftharpoons$

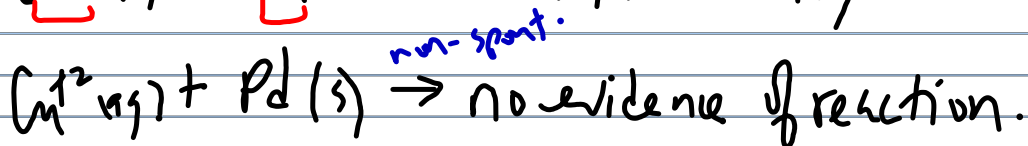
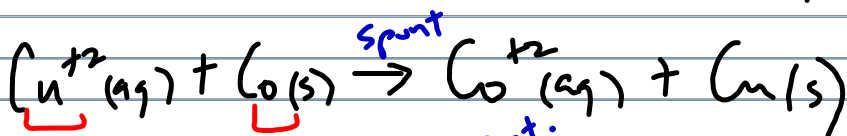
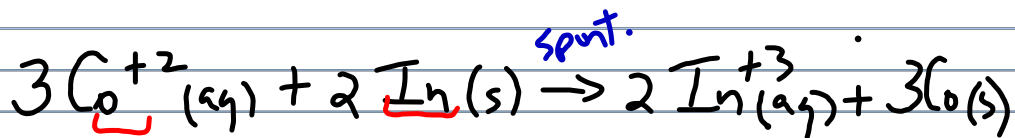


## Redox Spontaneity Rule

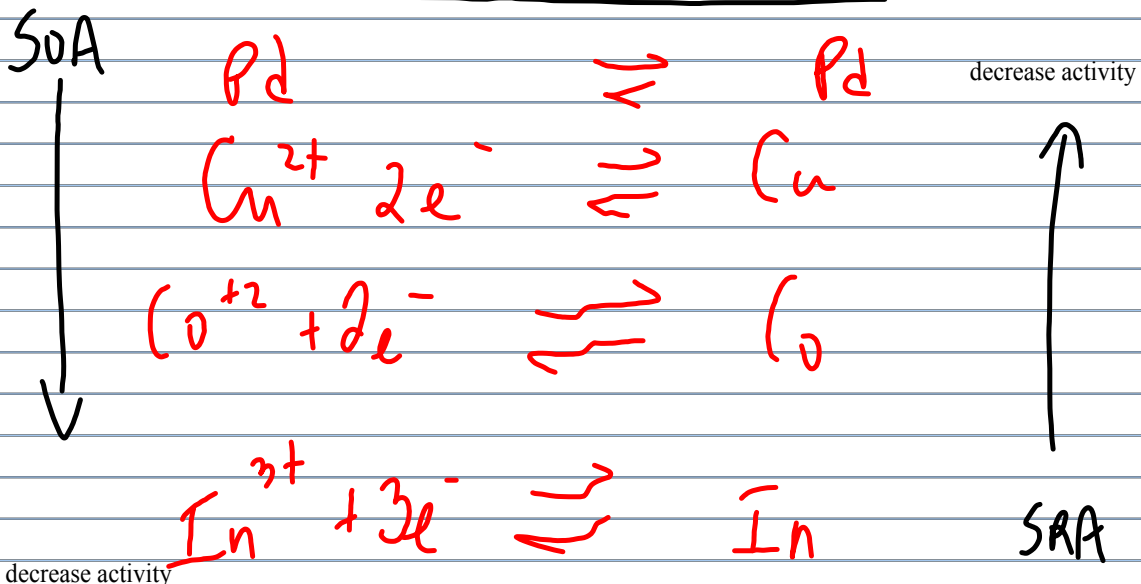
A spontaneous redox reaction occurs only if the oxidizing agent is above the reducing agent in the table of redox half rxns.



Redox tables can be built by analyzing net ionic equations and observations about Spontaneity.



Redox Half-Reactions



# Worksheet - #63