




LEO
t
h
e
L
i
o
n
S
a
y
s
G
E
R



REDOX

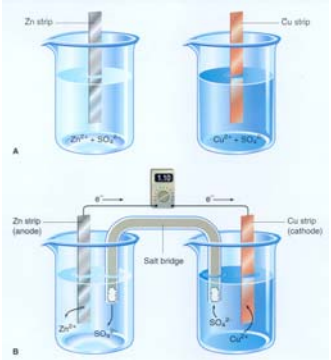


Reduction and Oxidation



LEO
Loss of Electrons
is Oxidation

GER
Gain of Electrons
is Reduction



LEO GER vs. OIL RIG

- **LEO** **GER**
 - **L** _____ of **E** _____ = **O** _____
 - **G** _____ of **E** _____ = **R** _____

- **OIL** **RIG**
 - **O** _____ **i** **L** _____
 - **R** _____ **i** **G** _____

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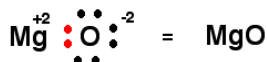
LEO GER continued

- Ex. Ionic bond between Magnesium and Oxygen

Magnesium Oxide



Magnesium loses 2 electrons, and Oxygen gains 2 electrons to have an Octet.



Magnesium is _____
(and acts as the _____
agent)

Oxygen is _____
(and acts as the _____
agent)

C. Ophardt, c. 2003

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Oxidation Numbers

- relate amount of electrons _____ by an atom or ion in a reaction
- Rules for Oxidation Number's:
- Uncombined/pure elements = _____
 - $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$
 - $\text{Mg} + \text{CuSO}_4 \rightarrow \text{MgSO}_4 + \text{Cu}$
- Compounds/Molecules have oxidation _____
 - $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$ (Ox. #'s are only in water)
 - $\text{Mg} + \text{CuSO}_4 \rightarrow \text{MgSO}_4 + \text{Cu}$

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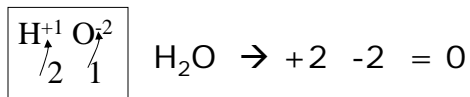
Rules for Oxidation Number's continued

- Monatomic ions have oxidation #'s _____ to their _____
 - NaCl \rightarrow Na⁺¹ + Cl⁻¹
- Group 1 are all ____ / Group 2 are all ____
- Fluorine is always ____, while other halogens are usually ____, except when bonded to a _____ electronegative element
- Hydrogen usually ____, except when bonded to a _____, then it is ____
 - HNO₃ = H is +1 NaH = H is -1

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Rules for Oxidation Number's continued

- Oxygen usually ____, except when bonded with _____, then it is ____
- Polyatomic ions have oxidation #'s equal to their ionic charge
- ****Note for molecules/compounds/polyatomic ions:**
subscripts need to be multiplied with charge for each atom to determine overall charge



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Determining if REDOX (reduction/oxidation) has occurred

- Did oxidation # change?
 - Assign _____ to all atoms in reactants and products to _____
 - If _____, REDOX occurred
- Is an atom in a compound on one side and _____ on the other?
 - If _____, REDOX occurred
 - Ex. $2\text{HCl} \rightarrow _ + _$
- Did a double replacement reaction occur?
 - These are typically _____ rxn's
 - Verify by checking all _____

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Determining if it is OXIDATION or REDUCTION

- If atoms have ___ in oxidation # = OXIDATION
 - They become more _____ (_____ of e-)
 - $-1 \rightarrow _ , +1 \rightarrow _ , 0 \rightarrow _$
- If atoms have ___ in oxidation # = REDUCTION
 - They become _____ (_____ of e-)
 - $0 \rightarrow _ , +4 \rightarrow _$

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Solve the following

- determine which is oxidized and reduced by listing all changes in oxidation #



•	<u>Reactants</u>	→	<u>Products</u>	<u>Result</u>	
•	Mn	→	Mn	=	_____
•	O	→	O	=	_____
•	H	→	H	=	_____
•	Cl	→	Cl	=	_____
•	Cl	→	Cl	=	_____

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Reducing Agents

- Material Oxidized is known as the _____ agent

– Reducing Agent: material that causes _____ to be _____ by giving it electrons as it is _____

- Ex. Chlorine is oxidized in above example as it loses/gives e- to manganese

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Oxidizing Agents

- Material Reduced is known as the _____ agent
 - Oxidizing Agent: material that causes _____ to be _____ by taking electrons as it is _____
 - Ex. Manganese is reduced in above example as it gains/takes e⁻ from chlorine

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Reducing and Oxidizing Agents

- Ex. $2\text{HCl} \rightarrow \text{H}_2 + \text{Cl}_2$
 - $\text{H} \rightarrow \text{H} = \text{_____} = \text{_____}$ and acts as _____ agent
 - $\text{Cl} \rightarrow \text{Cl} = \text{_____} = \text{_____}$ and acts as _____ agent
- What is the Reducing/Oxidizing agent for the following:
 - $4\text{HCl} + \text{MnO}_2 \rightarrow \text{MnCl}_2 + 2\text{H}_2\text{O} + \text{Cl}_2$
 - Reducing= _____ Oxidizing= _____

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Half Reactions

- Breaks REDOX into ___ equations to show loss/gain of e-
 - 2 half reactions can be put together to make complete reaction
- Follows conservation of _____, _____ and _____
- Reduction: atoms/ions gain 1 or more e-
 - Oxidation #'s _____
 - $\text{Fe}^{+3} + \text{_____} = \rightarrow \text{Fe}^0$ (shows gain on reactant side)
- Oxidation: atoms/ions lose 1 or more e-
 - Oxidation #'s _____
 - $\text{Fe}^0 \rightarrow \text{Fe}^{+3} + \text{_____}$ (shows loss on product side)

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Half reaction for REDOX

- $\text{Cu} + 2\text{AgNO}_3 \rightarrow \text{Cu}(\text{NO}_3)_2 + 2\text{Ag}$
- HINT: Assign oxidation #'s and eliminate any that may not have changed
- $\text{Cu} + 2\text{Ag}(\text{NO}_3) \rightarrow \text{Cu}(\text{NO}_3)_2 + 2\text{Ag}$
- Eliminate the Nitrate ions (as they do not change)
- Do half reactions for Copper and Silver
 - $\text{Cu}^0 \rightarrow \text{Cu}^{+2} + 2\text{e}^-$
 - $2\text{Ag}^{+1} + 2\text{e}^- \rightarrow 2\text{Ag}^0$
- Shows conservation of matter, mass and charge

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Electrochemistry

- _____ caused by the flow of _____ in a REDOX reaction
- Occurs in Electrochemical Cells (2 types)
 - Voltaic: _____ reactions produce flow of electrons
 - $\text{Zn} + \text{Pb}(\text{NO}_3)_2 \rightarrow \text{___} + \text{_____}$
 - Table J= _____ is higher than _____ and will replace it in a _____ reaction

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Electrochemical Cells (2 types) continued

- Electrolytic: _____ needed to force a _____ reaction to occur and for electrons to flow
 - $\text{Zn} + \text{Al}(\text{NO}_3)_3 \rightarrow \text{_____} + \text{_____}$
 - Table J=Zn is _____ than Al and _____ replace it spontaneously
 - Energy source needed to force the reaction to occur

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Anode vs. Cathode



- Cells contain 2 surfaces (electrodes) that conduct electricity

– Anode → where _____ occurs
(_____)



– Cathode → Where _____ occurs
(_____)



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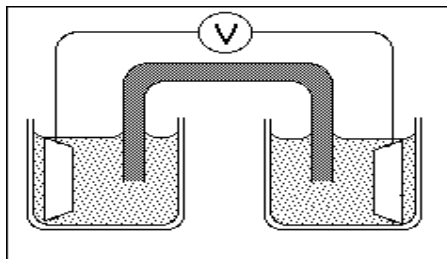
Spontaneous Reactions associated with Voltaic Cells

- Table J → determine which is anode/cathode and which is oxidized/reduced
 - Anode/Oxidation = AnOx = _____
element on table
 - Cathode/Reduction = RedCat = _____
Element on table
 - Ex. $\text{Zn} + \text{Pb}(\text{NO}_3)_2 \rightarrow \text{Pb} + \text{Zn}(\text{NO}_3)_2$
 - _____ is higher = _____
 - _____ is lower = _____

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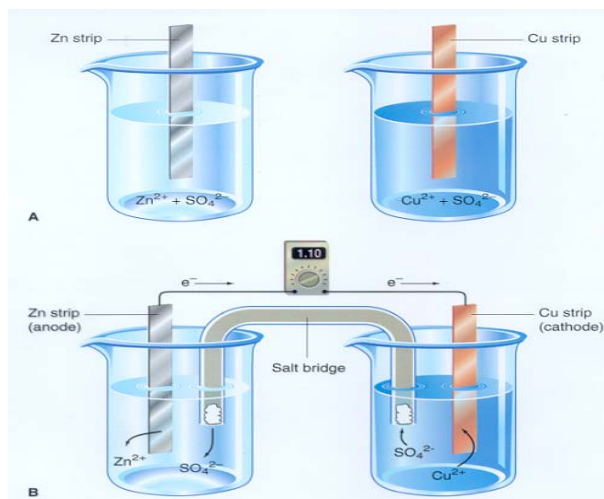
Salt Bridge-Spontaneous Rxn

- A salt bridge may also be used to _____ separate solutions and allow for a complete _____
 - Ions would flow between beakers along a wire



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Salt Bridge continued



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Voltaic vs. Electrolytic Cells

Anode (____) and _____ metal on table J	Anode (____) and _____ metal on table J
Cathode (____)and _____ metal on table J	Cathode (____) and _____ metal on table J
_____ Salt bridge completes circuit	_____ as energy is needed (electroplating and electrolysis)

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Voltaic vs. Electrolytic Cells

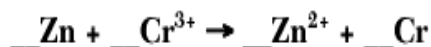
- _____ are REDOX reactions
- Current always flows from _____ to

- _____ is always Oxidation
- _____ is always Reduction

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Sample Problems:

- 1. Balance the following redox reaction using the *smallest* whole-number coefficients

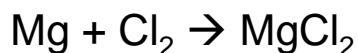


- 2. What happens to the number of protons in a Zn atom when it changes to Zn^{2+} as in the previous redox reaction?

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Sample Problems:

- 3. What is the oxidation number of chromium in $\text{K}_2\text{Cr}_2\text{O}_7$
- 4. Complete balanced half reactions for the following:



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