

Lecture 11: Electrochemistry

Introduction

- Reading: Zumdahl 4.10, 4.11, 11.1
- Outline
 - General Nomenclature
 - Balancing Redox Reactions (1/2 cell method)
 - Electrochemical Cells

Nomenclature

- “Redox” Chemistry: Reduction and Oxidation
- Oxidation: Loss of electrons
- Reduction: Gain of electrons
(a reduction in oxidation number)

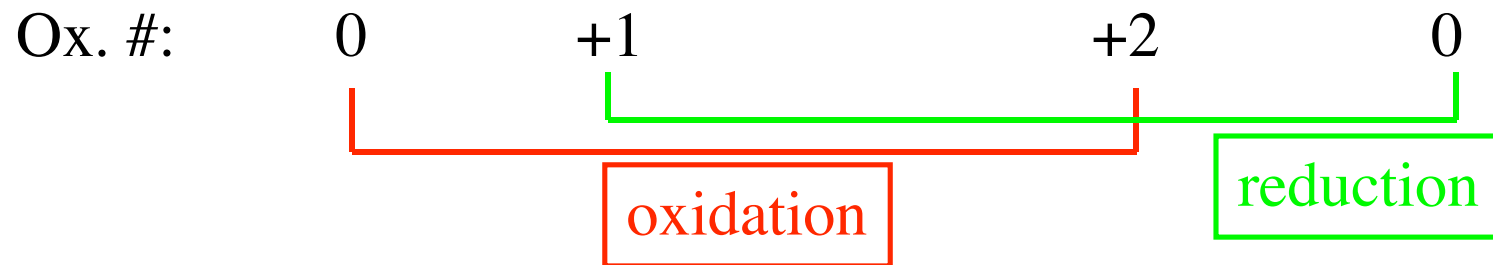
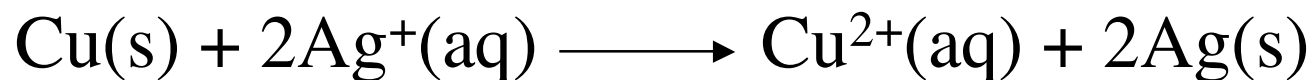
LEO goes **GER**

Loss of **E**lectrons is **O**xidation

Gain of **E**lectrons is **R**eduction

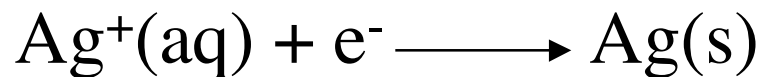
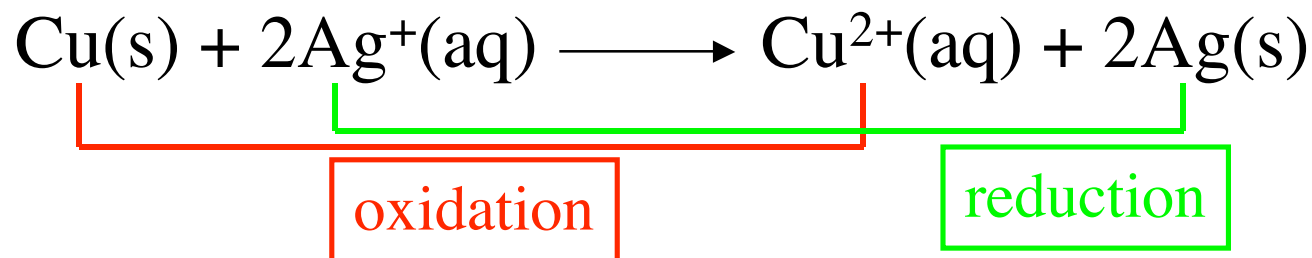
Redox Reaction Example

- A redox reaction:



Redox Reaction Example (cont.)

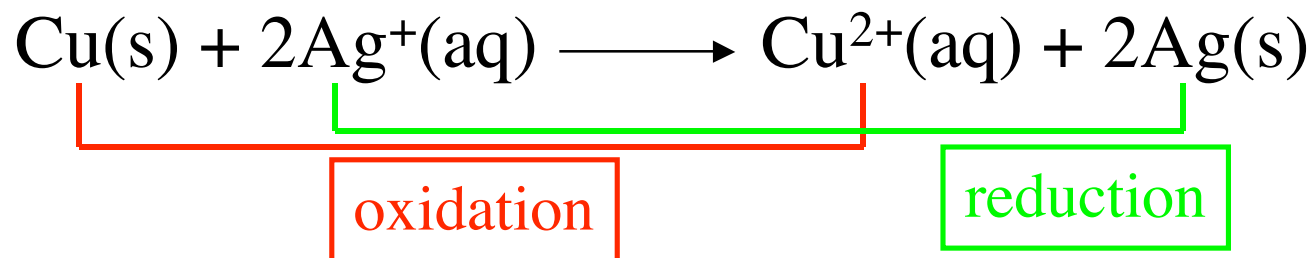
- We can envision breaking up the full redox reaction into two 1/2 reactions:



“half-reactions”

Redox Reaction Example (cont.)

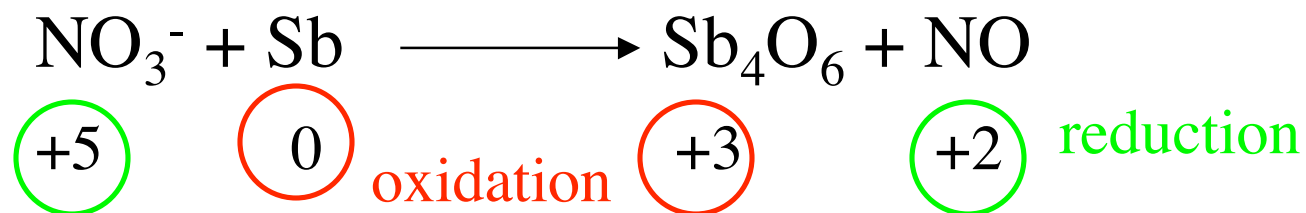
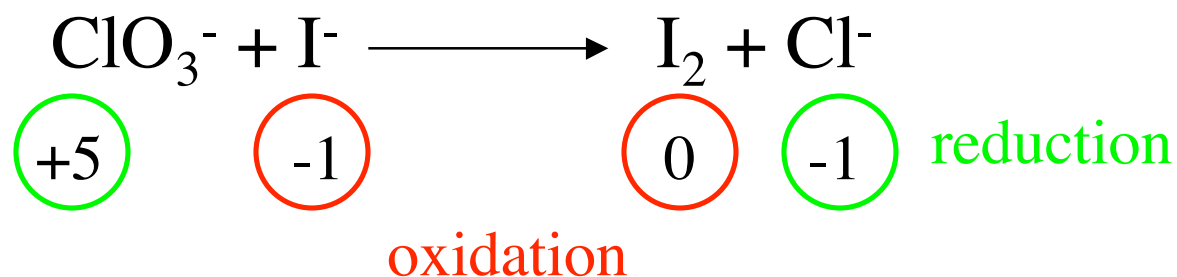
- Note that the 1/2 reactions are combined to make a full reaction:



- The important thing to remember: electrons are neither created or destroyed during a redox reaction. They are transferred from the species being oxidized to that being reduced.

Example

- Identify the species being oxidized and reduced in the following (unbalanced) reactions:



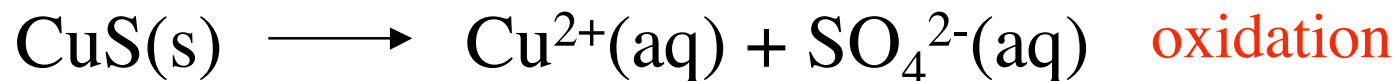
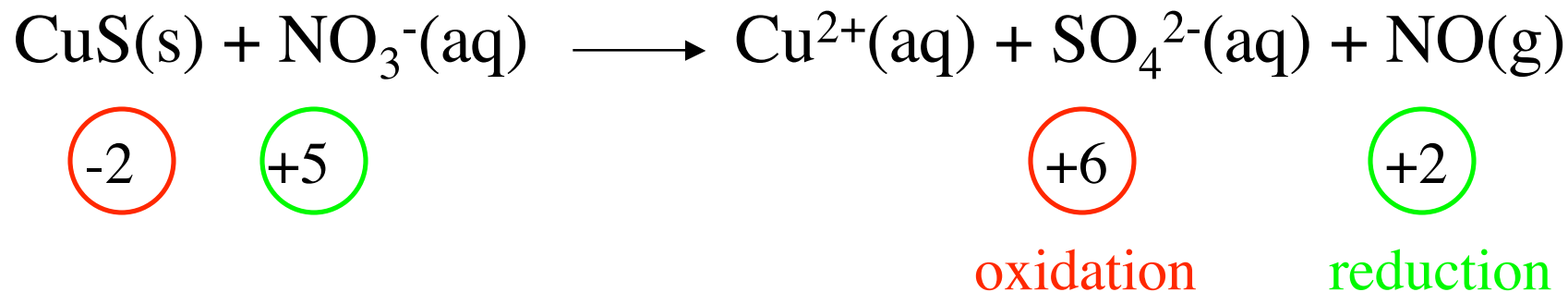
Balancing Redox Reactions

- Method of 1/2 reactions (my favorite)
- Key idea....make sure e^- are neither created or destroyed in final reaction.
- Let's balance the following reaction:



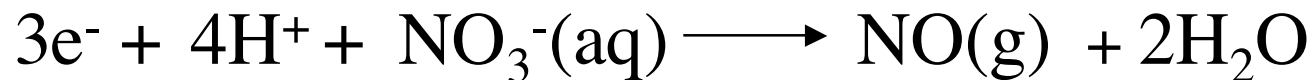
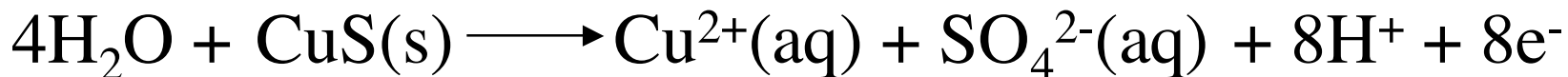
Balancing (cont.)

- Step 1: Identify and write down the unbalanced 1/2 reactions.



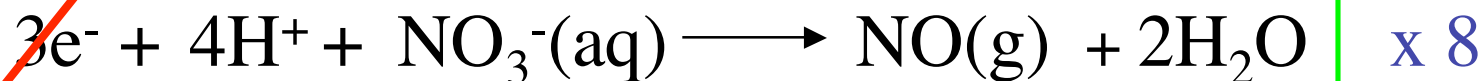
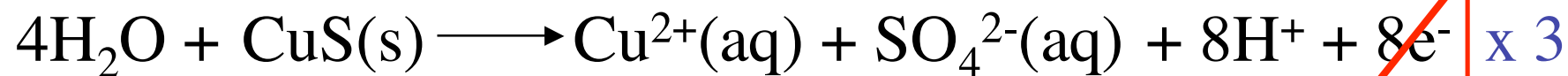
Balancing (cont.)

- Step 2: Balance atoms and charges in each 1/2 reactions. Use H_2O to balance O, and H^+ to balance H (assume acidic media). Use e^- to balance charge.



Balancing (cont.)

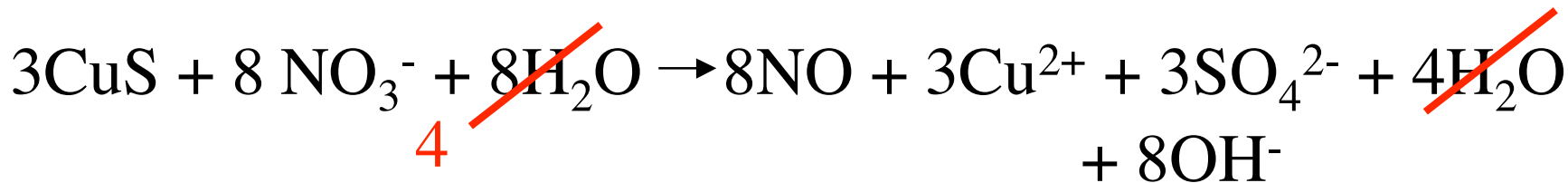
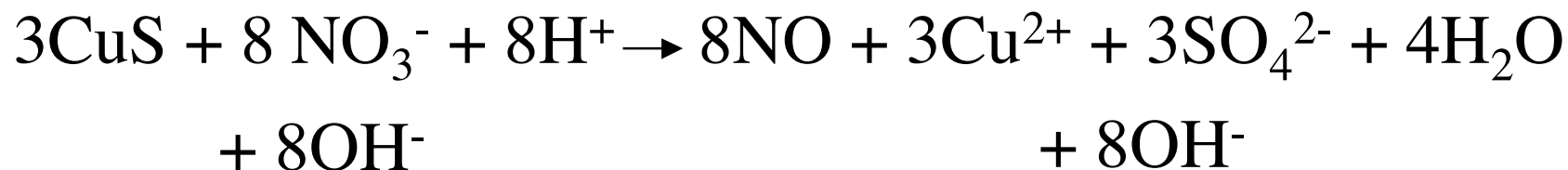
- Step 3: Multiply each 1/2 reaction by an integer such that the number of electrons cancels.



- Step 4: Add and cancel.

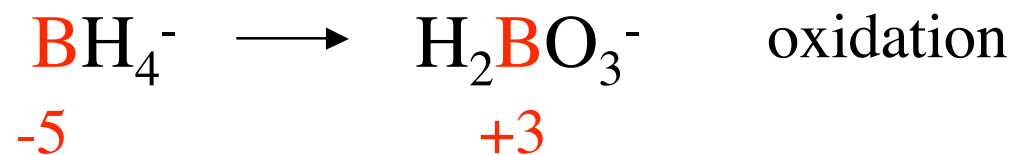
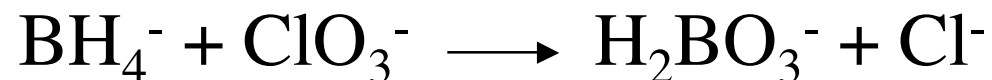
Balancing (end)

- Step 5. For reactions that occur in basic solution, proceed as above. At the end, add OH^- to both sides for every H^+ present, combining to yield water on the H^+ side.

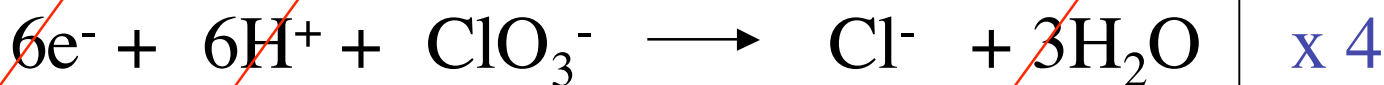


Example

Balance the following redox reaction occurring in basic media:



Example (cont)



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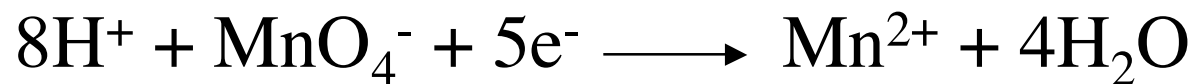
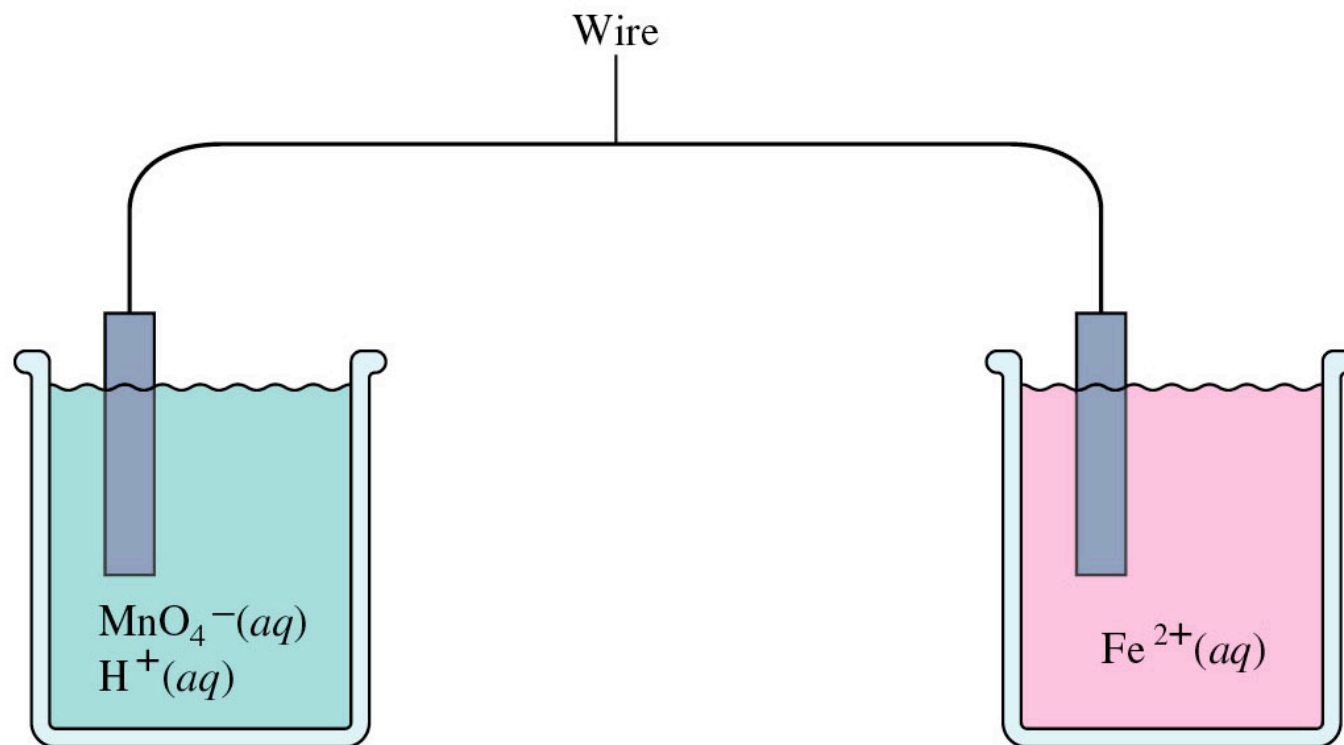


- Done!

Galvanic Cells

- In redox reaction, electrons are transferred from the oxidized species to the reduced species.
- Imagine separating the two 1/2 cells physically, then providing a conduit through which the electrons travel from one cell to the other.

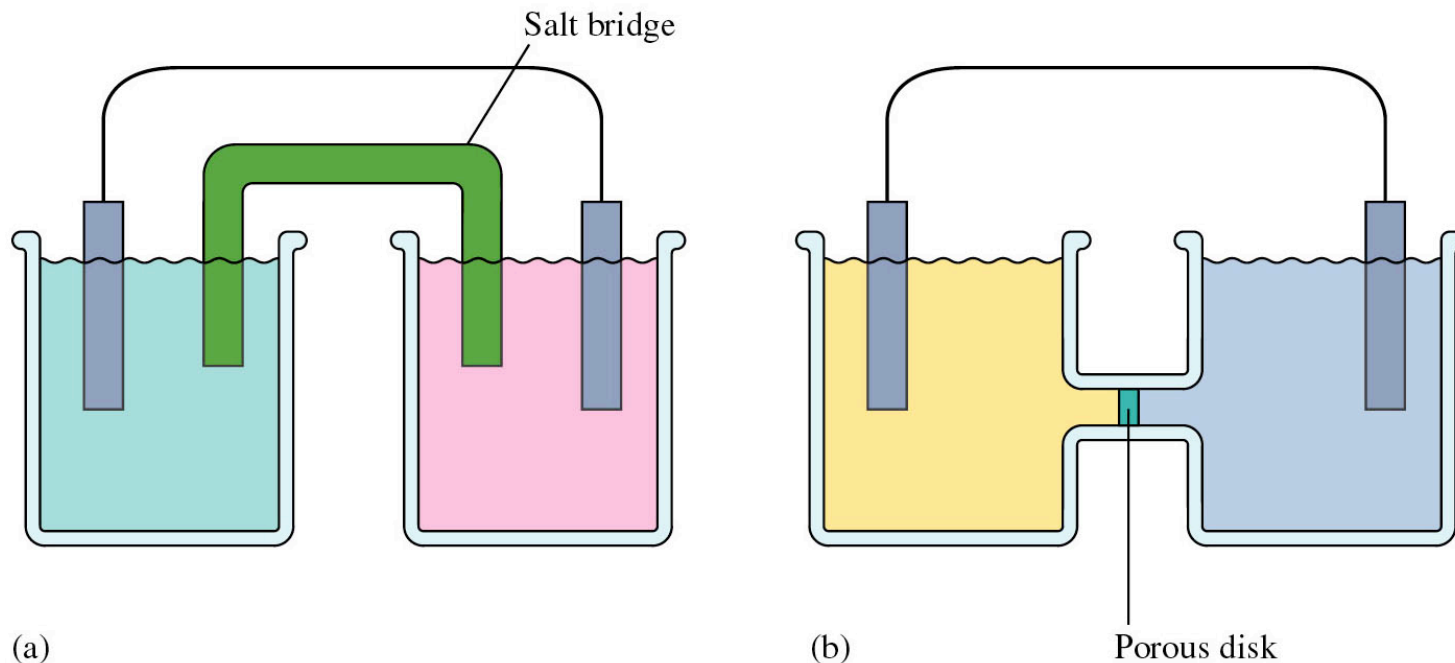
Galvanic Cells (cont.)



Galvanic Cells (cont.)

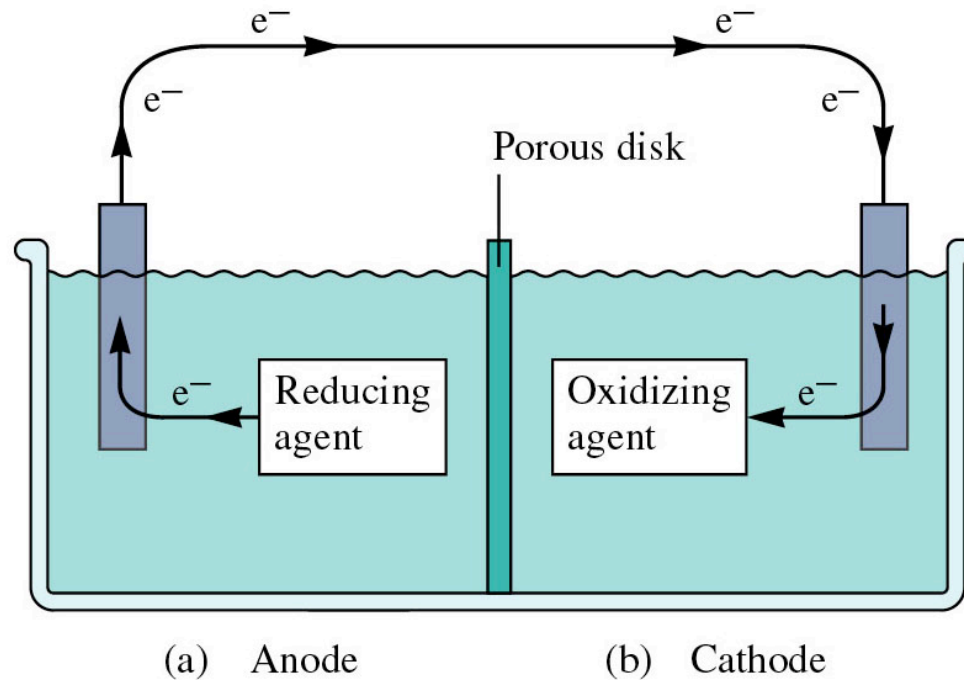
- It turns out that we still will not get electron flow in the example cell. This is because charge build-up results in truncation of the electron flow.
- We need to “complete the circuit” by allowing positive ions to flow as well.
- We do this using a “salt bridge” which will allow charge neutrality in each cell to be maintained.

Galvanic Cells (cont.)



Salt bridge/porous disk: allows for ion migration such that the solutions will remain neutral.

Galvanic Cells (cont.)



- Galvanic Cell: Electrochemical cell in which chemical reactions are used to create spontaneous current (electron) flow

