Lesson Overview
Electrochemical Cells

Objective: The student will be able to (1) describe the components of an electrochemical cell and (2) differentiate its two major types.

Real-World Applications

We are surrounded by an amazing array of portable electronic gadgets (cell phones, portable music players, laptops, and gaming devices.

What would our world look like without the batteries which power these devices?

Current research attempts to find batteries with more power, faster charging ability, lighter weight, or cheaper price.

Redox reactions happen here!

Introduction to Redox Terms

REDOX: tandem reactions of oxidation and reduction.

OXIDATION • One reactant loses electrons. • Reducing agent is oxidized. • Oxidation number increases.	Zinc **loses** electrons. Zinc is the reducing agent and becomes **oxidized**. The oxidation number of Zn **increases** from 0 to +2.
REDUCTION • Other reactant gains electrons. • Oxidizing agent is reduced. • Oxidation number decreases.	Hydrogen ion **gains** electrons. Hydrogen ion is the oxidizing agent and becomes **reduced**. The oxidation number of H **decreases** from +1 to 0.

OA / RA, OILRIG, show reactions, SYN of H_2O as non-example

Balancing REDOX Reactions

Let's try to balance this bad boy!

$$KOH_{(aq)} + KMnO_{4(aq)} + KI_{(aq)} \rightarrow$$

$$K_2MnO_{4(aq)} + KIO_{3(aq)} + H_2O_{(l)}$$

Balancing Redox Reactions
Half-Cell Method

Steps:

1. Divide the skeleton reaction into two half reactions.

2. Balnce the atoms and charges:

- **atoms: X ➔ O ➔ H**
- **charges: add electrons to balance charge**

3. multiply the electrons so they are equal

4. add half reactions and include SOM

[4b.] add OH^- (basic solution only)

5. Sight inspect (as a double check)

Ex. 1 $Cr_2O_7^{2-}{}_{(aq)} + I^-{}_{(aq)} \rightarrow Cr^{3+}{}_{(aq)} + I_{2(s)}$

[acidic solution]

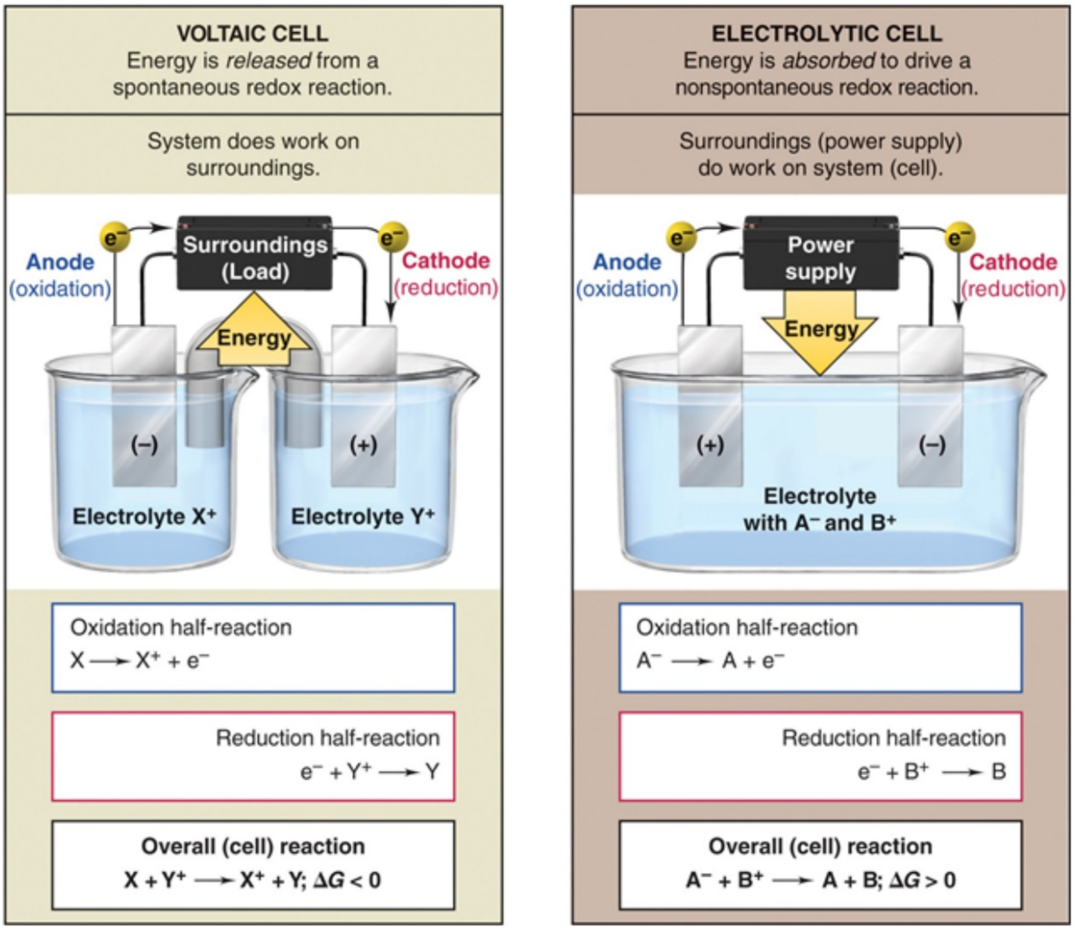
Ex.2 $MnO_4^-{}_{(aq)} + C_2O_4^{2-}{}_{(aq)} \rightarrow MnO_{2(s)} + CO_3^{2-}{}_{(aq)}$

[basic solution]

Practice 1

$MnO_4^- + I^- \rightarrow MnO_4^{2-} + IO_3^-$ [basic solution]

Overview of Electrochemical Cells



Notation for a Voltaic Cell

anode **cathode**

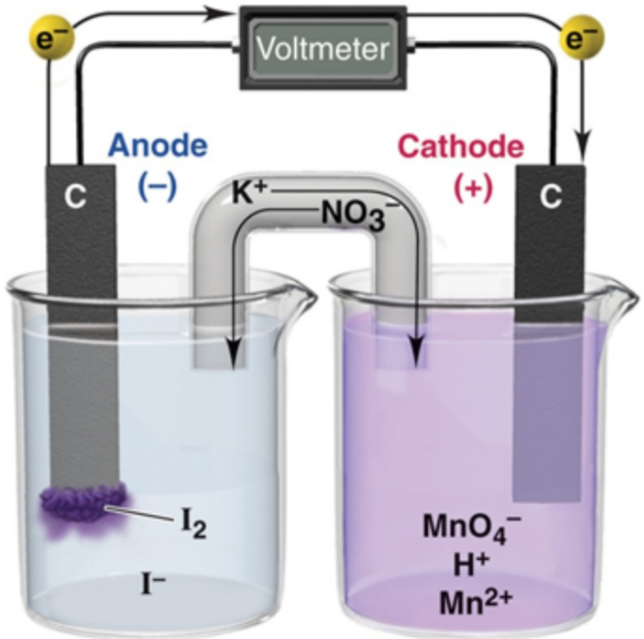
$$Zn(s)\,|\,Zn^{2+}(aq)\,\|\,Cu^{2+}(aq)\,|\,Cu(s)$$

- diff between single and double lines
- inclusion of concentrations (1M if not stated)
- diff. between inactive and active electrodes

Notation for a Voltaic Cell

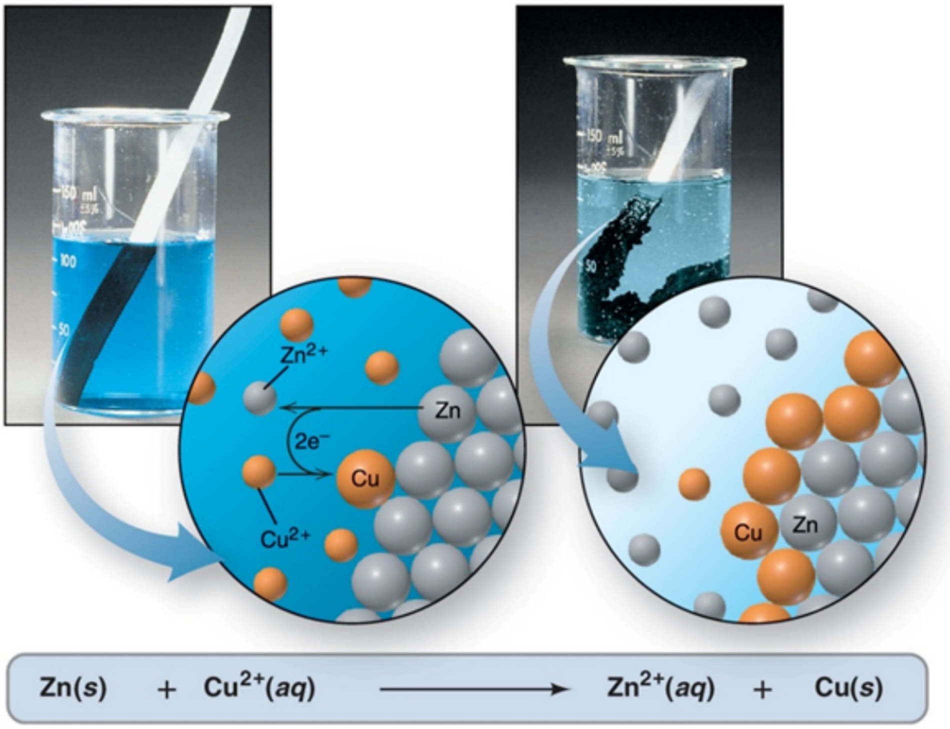
Graphite | $I^-_{(aq)}$ | $I_{2(s)}$ || $MnO_4^-{}_{(aq)}$, $H^+_{(aq)}$, $Mn^{2+}_{(aq)}$ | graphite

inert electrodes are shown



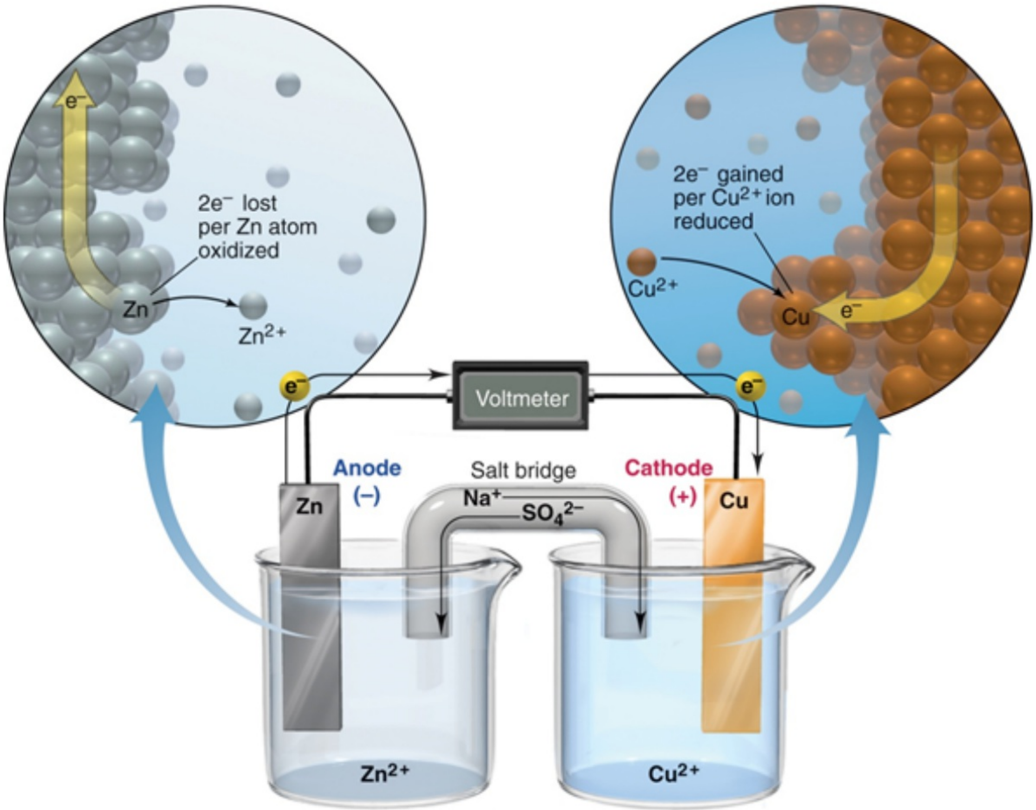
commas are used to show substances in the same phase

Standard State of Redox Reactions

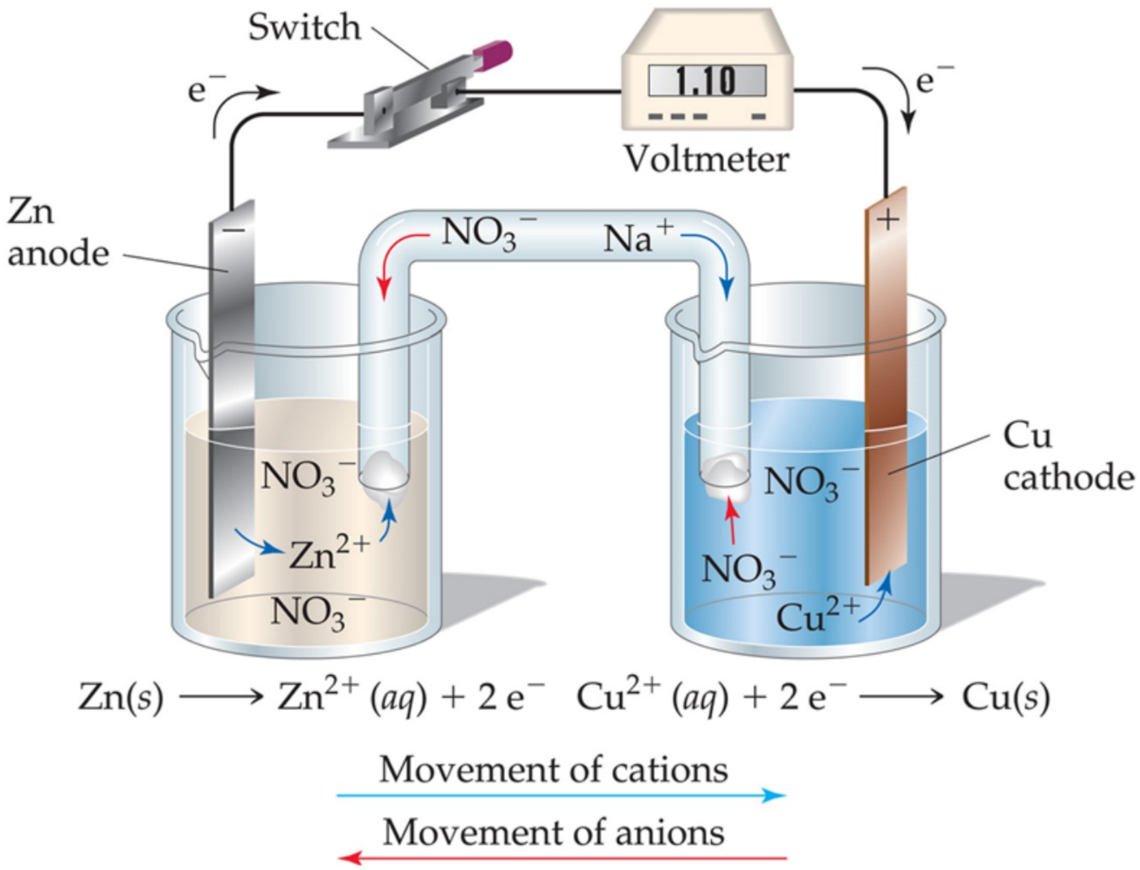


Electrochemical reactions are applied thermodynamic systems. Discuss standard conditions (SC) again.

Components of a Voltaic Cell



Movement of Charged Particles



Example Voltaic Cell

Draw a diagram, show balanced equations, and write the notation for a voltaic cell that consists of one half-cell with a chromium bar in a chromium(III) nitrate solution, another half-cell with a silver bar in a silver nitrate solution, and a potassium nitrate salt bridge. Measurement indicates that the chromium electrode is negative relative to the silver electrode.

Sample Problem Solution