3 electrochemistry things to help you prepare for the quiz on Thursday and the Final Exam:

1. **Determining relative strengths of oxidizing and reducing agents.** In working this kind of problem, note the similarities to relative acid/base strength problems. In both cases you start with a list of reactions:

<table>
<thead>
<tr>
<th>acid and base strength</th>
<th>oxidizing and reducing agent strength</th>
</tr>
</thead>
<tbody>
<tr>
<td>$K_a$ acid dissociation rxn</td>
<td>$E_{\text{red}}$ reduction half rxn</td>
</tr>
<tr>
<td>$10^{-2}$ HSO$_4^-$ $\leftrightarrow$ H$^+$ + SO$_4^{2-}$</td>
<td>10$^{-12}$</td>
</tr>
<tr>
<td>$10^{-3}$ HAc $\leftrightarrow$ H$^+$ + Ac$^-$</td>
<td>10$^{-9}$</td>
</tr>
<tr>
<td>$10^{-5}$ NH$_4^+$ $\leftrightarrow$ H$^+$ + NH$_3$</td>
<td>10$^{-5}$</td>
</tr>
</tbody>
</table>

HSO$_4^-$ is the strongest acid, NH$_3$ is the strongest base. Cu$^{2+}$ is the strongest oxidizing agent, Zn is the strongest reducing agent.

Things to notice:
- The are two directions for reactions: acids in the forward direction, bases in the reverse direction; reduction in the forward direction, oxidation in the reverse direction.
- There are two pairs of constants, $K_a$ and $K_b$, $E_{\text{red}}$ and $E_{\text{ox}}$.
- There are some simple rules for determining strength:
  - “The larger the $K_a$, the stronger the acid and the weaker the conjugate base”
  - “The larger the $K_b$, the stronger the base and the weaker the conjugate acid.”
  - “The stronger the oxidizing agent the more easily a species is reduced”
  - “The stronger the reducing agent, the more easily a species is oxidized.”
- In table as written, the strongest acid is always in the upper left hand corner (HSO$_4^-$) and the strongest base in the lower right hand corner (NH$_3$). The strongest oxidizing agent (most easily reduced) is always in the lower left hand corner (Cu$^{2+}$) and the strongest reducing agent is in the upper right hand corner (Zn).

2. **Famous modern batteries use a variety of chemicals to power their reactions. Typical battery chemistries include:**
- Zinc-carbon battery - Also known as a standard carbon battery. Zinc-carbon chemistry is used in all inexpensive AA, C and D dry-cell batteries. The electrodes are zinc and carbon, with an acidic paste between them that serves as the electrolyte.
- Alkaline battery - Used in common Duracell and Energizer batteries. The electrodes are zinc and manganese-oxide, with an alkaline electrolyte.
- Lithium photo battery - Lithium, lithium-iodide and lead-iodide, used in cameras because of its ability to supply power surges.
- Lead-acid battery - Used in automobiles. The electrodes are made of lead and lead-oxide with a strong acidic electrolyte. Rechargeable.
- Nickel-cadmium battery - Uses nickel-hydroxide and cadmium electrodes, with potassium-hydroxide as the electrolyte. Rechargeable.
- Nickel-metal hydride battery - Rapidly replacing nickel-cadmium because it does not suffer from the memory effect that nickel-cadmiums do. Rechargeable.
- Lithium-ion battery - Very good power-to-weight ratio, often found in high-end laptop computers and cell phones. Rechargeable.
- Zinc-air battery - Lightweight, rechargeable.
- Zinc-mercury oxide battery - Often used in hearing-aid batteries.
- Silver-zinc battery - Used in aeronautical applications because the power-to-weight ratio is good.
- Metal Chloride battery - Used in electric vehicles.

3. **A nice summary of facts on cell construction and convention:**

<table>
<thead>
<tr>
<th>electrochemical cell type</th>
<th>reaction type</th>
<th>$\Delta G$</th>
<th>$E$</th>
<th>reduction</th>
<th>oxidation</th>
<th>direction of e$^-$ flow</th>
<th>sign at cathode</th>
<th>sign at anode</th>
</tr>
</thead>
<tbody>
<tr>
<td>electrolysis</td>
<td>non-spontaneous</td>
<td>+</td>
<td>-</td>
<td>cathode</td>
<td>anode</td>
<td>e$^-$ flow to cathode</td>
<td>-</td>
<td>+</td>
</tr>
<tr>
<td>galvanic (battery)</td>
<td>spontaneous</td>
<td>-</td>
<td>+</td>
<td>cathode</td>
<td>anode</td>
<td>e$^-$ flow to cathode</td>
<td>+</td>
<td>-</td>
</tr>
</tbody>
</table>