

Admin:

Test #2 scheduled week 8, Fri Aug 10 . Test guide is posted online.**Last time:**

- 1) Nernst Equation
- 2) Concentration cells
- 3) how potentiometers work: pH meters

Today:

- 1) Applications: batteries
- 2) corrosion: cathodic protection

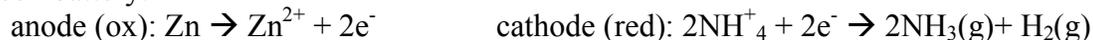
Lecture:

1) Application of galvanic cells for doing work: **Batteries:**

Useful for: flash lights, portable computers, cell phones, ..electric cars!

Primary batteries: *can't be reversed

a) dry cell battery:

H₂ removal: $2\text{MnO}_2 + \text{H}_2(\text{g}) \rightarrow \text{Mn}_2\text{O}_3(\text{s}) + \text{H}_2\text{O}(\text{l})$ carbon rod electrode is used.NH₃ removal: $\text{NH}_3(\text{g}) + \text{Zn}^{2+} + 2\text{Cl}^- \rightarrow \text{Zn}(\text{NH}_3)_2\text{Cl}_2(\text{aq})$ Net: $2\text{MnO}_2(\text{s}) + 2\text{NH}_4^+(\text{aq}) + \text{Zn}(\text{s}) \rightarrow \text{Mn}_2\text{O}_3(\text{s}) + \text{H}_2\text{O}(\text{l}) + \text{Zn}(\text{NH}_3)_2^{2+}(\text{aq})$

$$E_{\text{cell}} = E^\circ_{\text{cell}} - \left(\frac{.06}{2}\right) \log \left\{ \frac{[\text{Zn}(\text{NH}_3)_2^{2+}]}{[2\text{NH}_4^+]}\right\}$$

as the cell is used up, the log term increases in magnitude and E_{cell} decreases.

Disadvantage: poor shelf life, can't draw current too fast. E vs time, potential drops...

b) Hg battery: (used in calculators, cameras, watches, heart pacemakers, hearing aids ...)

anode: $\text{Zn}(\text{s}) + 2\text{OH}^- \rightarrow \text{ZnO}(\text{s}) + \text{H}_2\text{O}(\text{l}) + 2\text{e}^-$ cathode: $\text{HgO}(\text{s}) + \text{H}_2\text{O}(\text{l}) + 2\text{e}^- \rightarrow \text{Hg}(\text{l}) + 2\text{OH}^-$

net:

write the net rxn:

write the Nernst Equation

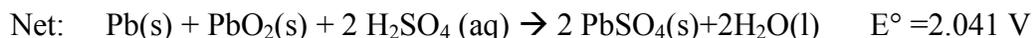
What is the characteristic E vs t curve?

Advantages: constant E

Disadvantages: Hg toxic!

Secondary Batteries:

Lead batteries: Used in cars



How do we get 12 V out of it?

What gets depleted as the battery runs down?

How to determine the strength of the battery? By a hydrometer: (determines the concentration of $\text{H}_2\text{SO}_4\text{(aq)}$ by measuring the density of the solution inside).

Advantage: simple, cheap, large current capability; reversible!(can be recharged)

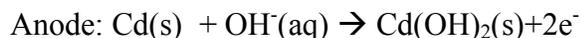
Disadvantage: heavy! Pb toxic.

If you “jump” the battery with an excess potential, or recharge it too quickly, you may cause electrolysis of water : O_2 and H_2 gases as side products will accumulate.

What happens if you have a spark???

KABOOM!

Other common secondary batteries: Nickel-Cadmium (Nicad) batteries:



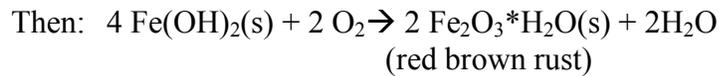
Net is : (you write it and analyze it)

Advantage? Lightweight, constant voltage, rechargeable

Corrosion:

What causes corrosion? Redox processes

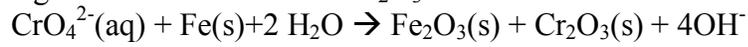
(happens when Fe is exposed, there's electrical contact between anode and cathode region, there's plenty of O_2 and H_2O .)



How to protect Fe from rusting?

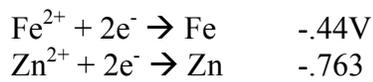
2 ways: a) barrier methods: coat it with an impervious layer: "Anodic inhibition"

e.g. oxidant used to form: Fe_2O_3 on the surface.



b) sacrificial metal methods: sacrifice another metal.

e.g.



Zn is oxidized before Fe is oxidized.

Zn is the sacrificial anode. Fe becomes the cathode: Cathodic protection.