Batteries

Batteries history

- Battery- combination on 2 or more electrochemical cells that convert chemical energy into electrical energy.
- Luigi Galvini and Allesandro Volta are credited with the invention of the first batteries.
- Galvini came up with the galvanic cell. Volta connected them together in a series.
- The name battery was coined by Benjamin Franklin, because the batteries at the time were a series of connected jars which reminded him of a battery of cannons.

Types of batteries

- Two major types are:
- Wet Cell batteries- use a liquid electrolyte to allow the ions to freely exchange during the redox reaction.
- Car batteries or batteries with a liquid inside.
- Dry Cell battery- use a paste that immobilizes the electrolyte.
- AA, AAA, C, D, 9V etc.

The electrolyte

- This is the salt bridge discussed earlier.
- It allows ions to flow freely while the electrons travel across our load, the thing you are trying to power.
- The electrolyte normally needs to be acidic or basic to make the redox reaction occur.
- Sulfuric acid is commonly used, it is commonly called battery acid.

Why not HCl

- HCl would be a very poor choice because of the redox reaction
- $2\ HCl \rightarrow H_2 + Cl_2$
- Hydrogen typically gets reduced
- $2\ H^+ + 2e^- \rightarrow H_2$
- But chlorine getting oxidized is very dangerous
- $2\ Cl^- \rightarrow 2e^- + \mathbf{Cl_2}$
- Because of the poisonous gas produced.

Wet Cell Batteries

- Car batteries are wet cell batteries.
- The obvious problem with these batteries is the need to be keep them upright or the electrolyte, sulfuric acid, will leak out.
- However the power they produce is quite substantial.

Lead-Acid

- The standard battery used in a car was invented in 1859 by Gaston Planté.
- It uses a Lead plate and a Lead Dioxide plate in a sulfuric acid solution.
- Here is the unbalanced redox reaction
- $Pb + PbO_2 + H_2SO_4 \rightleftharpoons PbSO_4$
- Reduction half
- $PbO_2 + H_2SO_4 \rightleftharpoons PbSO_4$
- Oxidation half
- $Pb + H_2SO_4 \rightleftharpoons PbSO_4$

Rechargeable

- The nice thing about this battery is it is easily rechargeable.
- $PbSO_4$ will readily form Pb and PbO_2 if electric current is added back to the cell.
- This happened completely by chance since there was no practical way to recharge the battery when it was invented.
- Later the generator would be invented and from that a car's alternator and easily recharge the battery while you drive.

Alkaline Batteries

- Normal AA AAA C and D batteries are alkaline.
- These are dry cell batteries
- The reaction is
- $Zn + MnO_2 \rightarrow ZnO + Mn_2O_3$
- This occurs in a paste of KOH.
- This reaction is not reversible!
- https://www.youtube.com/watch?v=9OVtk6G2TnQ

These may leak if you try to recharge them.

Strangely enough

- A single AA, AAA, C or D "battery" is not a battery by definition.
- They are all single cells.
- They are not a battery until you connect them together, like you have to in most devices.
- A 9 V battery is a battery because it has 6 cells linked together in the rectangular case.
- Car batteries also have 6 cells linked together.

Lithium Ion Batteries

- Commonly used in cell phones, laptops and other portable electronic devices.
- Not to be confused with Lithium single use batteries (like energizer e^2).
- These batteries are rechargeable.
- There use a lithium compound as the cathode and variety of possibilities for the anode material.

Li-Ion

Lithium Ion Batteries

- These batteries are very light for the power the produce
- They can be built to a variety of shapes to fit their device.
- Over time, the battery will not be able to hold as much of a charge so it will need to be recharged more often.
- It will take less time to recharge when this occurs.

Other batteries

- **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.
- **Nickel-cadmium battery (NiCd)-** The electrodes are nickel-hydroxide and cadmium, with potassium-hydroxide as the electrolyte (rechargeable).
- **Nickel-metal hydride battery (NiMh)-** This battery is rapidly replacing nickel-cadmium because it does not suffer from the memory effect that nickel-cadmiums do (rechargeable).

Other batteries

- **Lithium-iodide battery** - Lithium-iodide chemistry is used in pacemakers and hearing aides because of their long life.
- **Zinc-air battery** - This battery is lightweight and rechargeable.
- **Zinc-mercury oxide battery** - This is often used in hearing-aids.
- **Silver-zinc battery** - This is used in aeronautical applications because the power-to-weight ratio is good.

Recycling

- All batteries break down over time.
- Rechargeable batteries normally produce some other compound through an irreversible reaction.
- **All** batteries contain caustic chemicals that are potentially hazardous to the environment.
- **None** should be put into landfills as they will eventually break down and leak over time.
- Car batteries are almost all recycled (like 98%). You can recycle them anywhere that sells car batteries (Autozone, Sears etc.).

Where to recycle

- Power tool batteries (NiCd/NiMH or Li-Ion) can be recycled at Home Depot. As soon as you walk in, to the left there is a bin.
- Electronics batteries (Li Ion) can be recycled at Best Buy. The bin is in that area when you first walk in before you get into the actual store.
- The e check is also taking cell phone batteries currently.
- Regular batteries can be recycled at the hazardous household waste center in Stow. http://www.summitreworks.com/