



Introduction to Lead-Acid Batteries

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Tonight's Topics

- Safety
- Electrochemistry basics
- Battery Types for Radio Use
- Battery Ratings
- Charging, Housekeeping and Operation





Battery Safety

- You are responsible for your safety and that of others
- Even small lead-acid batteries can deliver a lot of current and heat in a short circuit situation
- Use insulated tools when making/breaking bolted connections to minimize the possibility of sparking
- Protect your eyes - wear safety glasses, goggles, face shields
- Use wire that can safely and effectively carry the maximum current the application requires
- Use protective devices in circuits such as fuses or resettable breakers



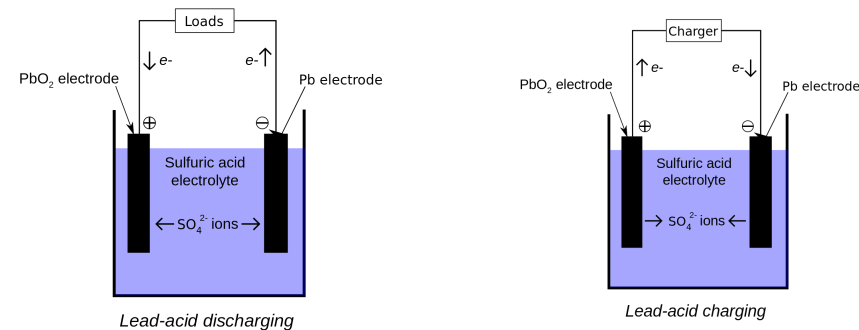
Electrolyte Safety

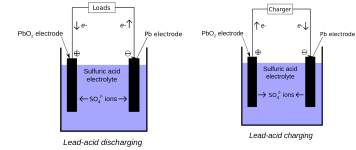
- Lead-acid batteries employ a diluted solution of Sulfuric acid and water
- Concentration is about 35% acid, 65% water
- Acid in the eyes can cause blindness
- For ham radio, maintenance-free batteries are recommended – no acid issues



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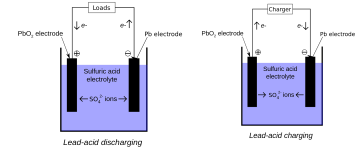
Electrochemistry Basics





Electrochemistry Basics

- To construct a battery, four basic components are required
 - Positive plates
 - Negative plates
 - Electrolyte
 - Electrical separator
- Materials
- + plates = lead dioxide
- - plates = sponge lead
- Dilute sulfuric acid and water
- When fully charged, these essential materials result in a nominal voltage of **2 volts** to make a cell – **the building block of any battery**



Electrochemistry Basics

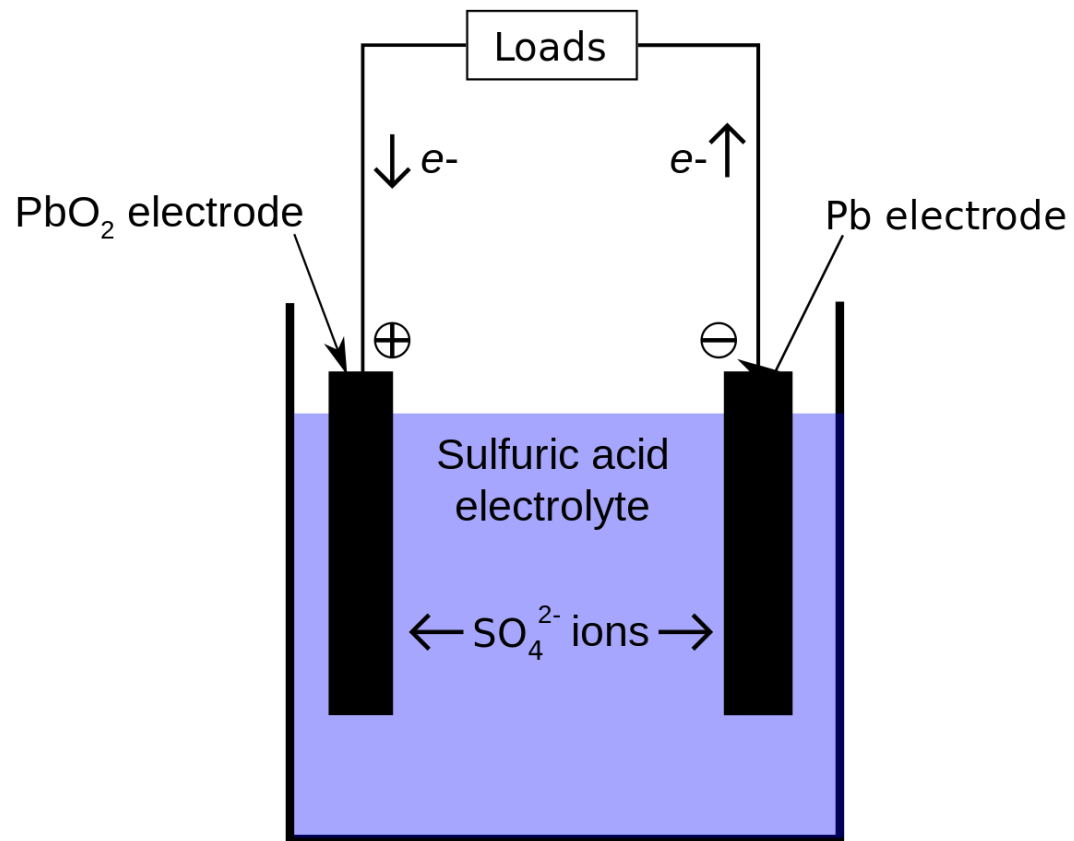
- Comparing nominal voltages of common rechargeable batteries
 - Lead-acid – 2 volts
 - Nickel Cadmium – 1.2 volts
 - Nickel Metal Hydride – 1.2 volts
 - Lithium – 3.3 to 3.7 volts depending on specific chemistry

Electrochemistry Basics – How it Works

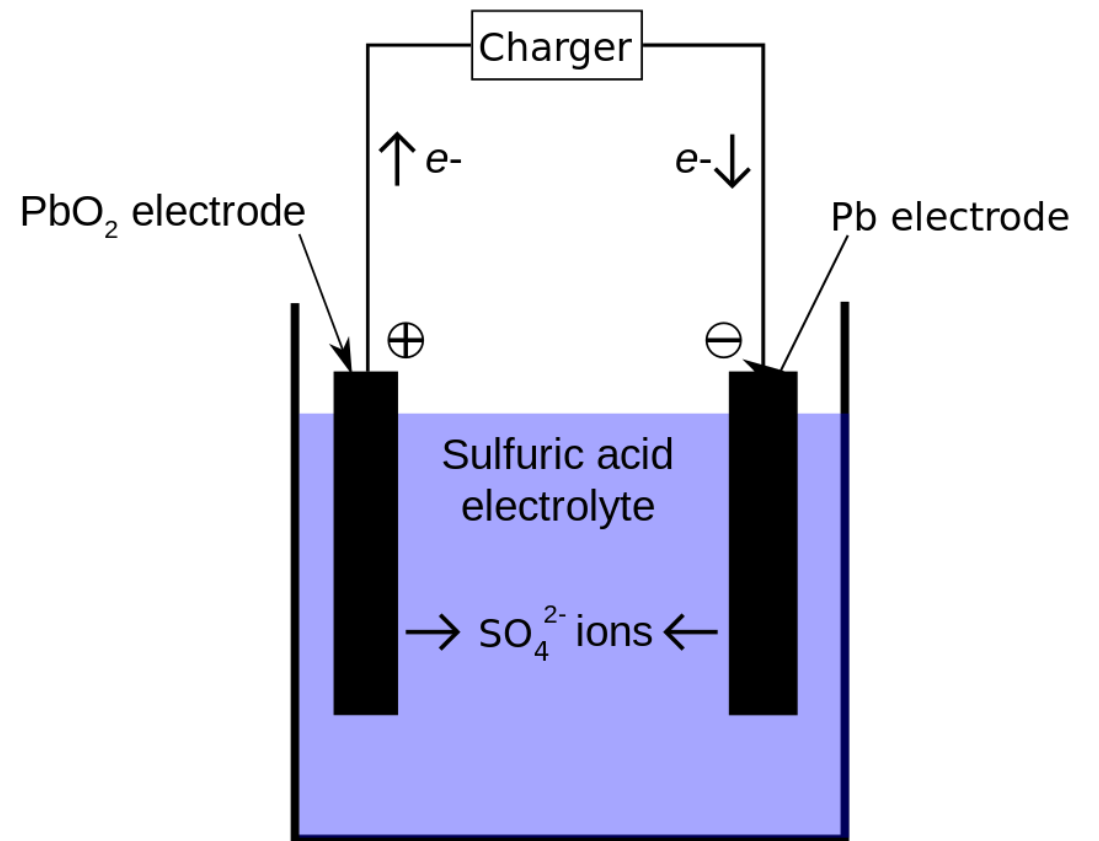


- Fully charged electrode (plate) materials are at their highest readiness for use. Electrolyte specific gravity is at maximum – about 1.300
- During discharge, the current in the cells of the battery flows from the positive to negative of each cell in the battery
- Sulfuric acid is pulled into the plates, reducing the specific gravity which increases water
- Battery voltage is decreasing as the “fuel” in the cells is being used up
- Eventually, the battery will no longer be able to supply useful energy to the load and it must be recharged

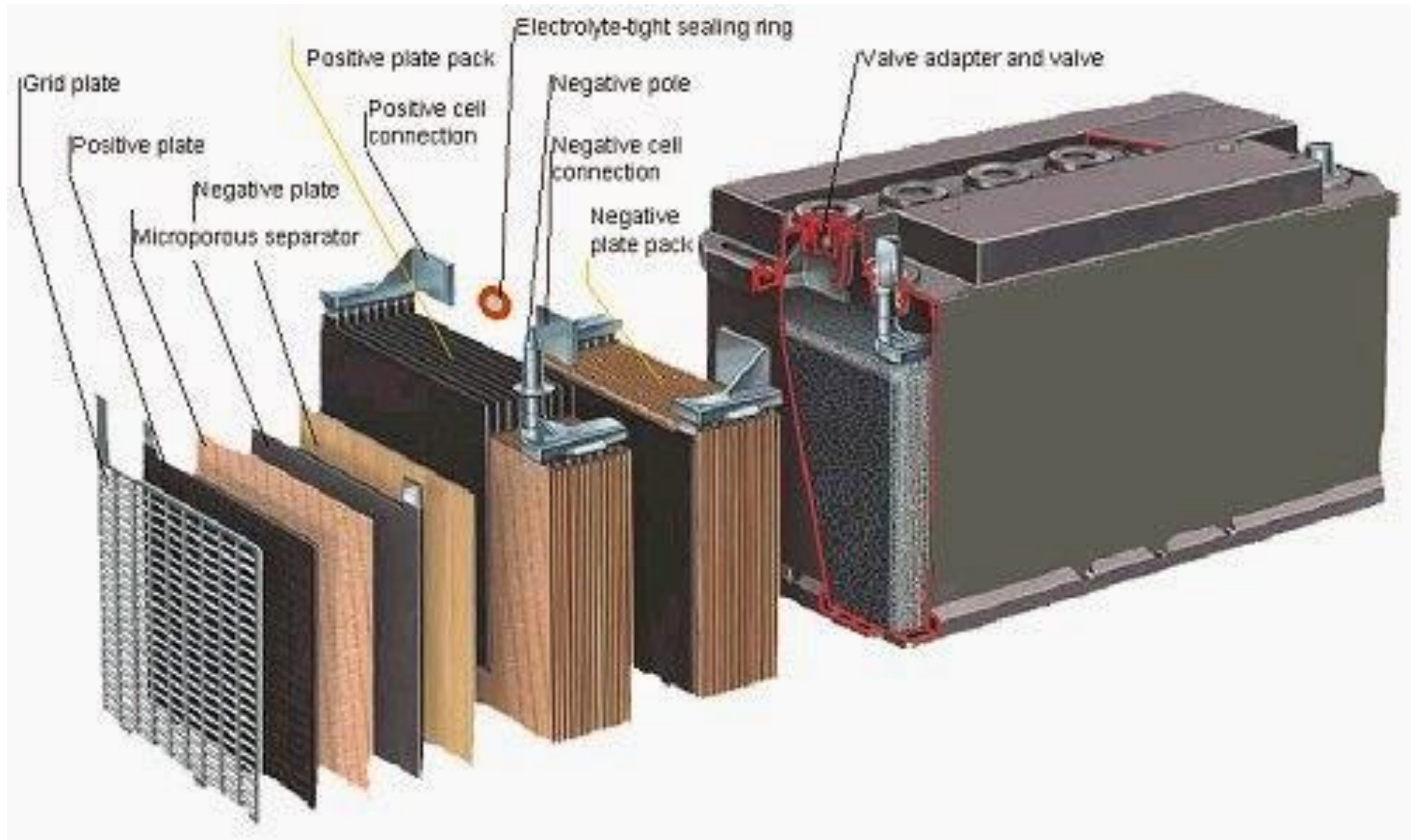
Electrochemistry Basics – How it Works



Lead-acid discharging



Lead-acid charging



Typical 12 Volt Lead-Acid Battery Construction

Battery Types for Ham Radio





Battery Types for Ham Radio

- Overall, the best bet for our application is still a maintenance-free 12 volt lead-acid battery capable of long duration operations
 - Portable
 - Widely available
 - Reasonable price
 - Recyclable
 - Wide range of available sizes
 - Easily paralleled to increase capacity
 - Widely available and economical chargers



Battery Types for Ham Radio

- The application for our radios is long duration, low current
 - Basically, defined as any discharge that is more than one hour



Battery Ratings

Battery Ratings

- For the purpose of this discussion, we will talk *ampere-hours*
- This is just amps X hours
- A discharge of 5 amps for 8 hours = 40 ampere-hours (amp hours)
- Amp hours must be discussed in a specific context
 - Operating temperature
 - Time
 - Current
 - End of discharge voltage

Battery Ratings Example

End Voltage 1.85 Vpc
Ampere Rating for Minutes to Specified End Voltage at 77°F (25°C)

PowerSafe® HX Battery	Minutes				Hours									
	1	15	30	45	1	2	3	4	5	6	7	8	10	20
12HX205	236.2	89.3	54.7	39.9	31.6	17.6	12.2	9.5	7.8	6.7	5.8	5.2	4.3	2.3
12HX300	313.1	128.1	82.5	60.8	48.6	28.1	20.2	15.8	13.0	11.1	9.7	8.6	7.0	3.6
12HX330	358.4	153.7	96.7	71.2	56.8	32.8	23.5	18.4	15.2	12.9	11.3	10.0	8.1	4.2
12HX400	406.6	174.2	109.2	81.1	64.9	37.5	26.9	21.1	17.4	14.8	12.9	11.4	9.3	4.8
12HX540	420.1	227.8	146.6	108.9	87.0	48.9	34.5	26.9	22.1	18.9	16.5	14.7	12.1	6.5

Context of Ratings

End of discharge voltage: 1.85 volts per cell (11.1 volts)

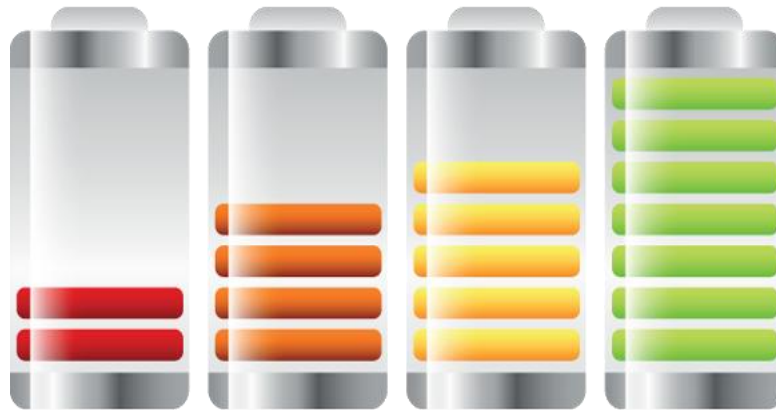
Temperature” 77 degrees, F.

Discharge time: 20 hours

Current: 5.2 amps



Charging, Operation and Housekeeping



Charging



- Use battery chargers intended for the type of battery you have
 - Maintenance free lead-acid AGM, gel types
 - Unless specified as such, DC power supplies are NOT battery chargers
- Consider using a Battery Tender to trickle charge you batteries so they are always ready for service



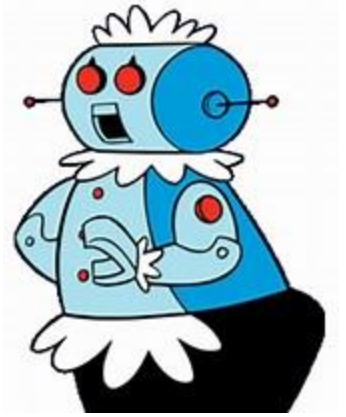
Battery Tender

Operation

- Monitor battery voltage during operation
- Use the largest wire practical between the battery and the loads to minimize voltage drop and to extend run time
- Insulate battery terminals to avoid accidental short circuiting
- Charge batteries as soon as possible after discharging
- Discharged batteries can be permanently damaged



Housekeeping



- Never lift batteries by the terminals!
- Keep clean and avoid using harsh chemicals
- Replace any batteries when it begins leaking around the terminal seals, cover-to-container seals or when the battery become damaged
- Store fully charged in a cool location
- Charge every 6 months when not in operation
- Recycle all batteries – do NOT toss in the trash