B-cycle Battery Recycling

Fact Sheet

How do batteries work?

The anatomy of a battery

Batteries are devices that store chemical energy, ready for conversion into electrical energy when we put them to use[i].

All batteries have three key components - an **anode** a **cathode** and **electrolyte**.

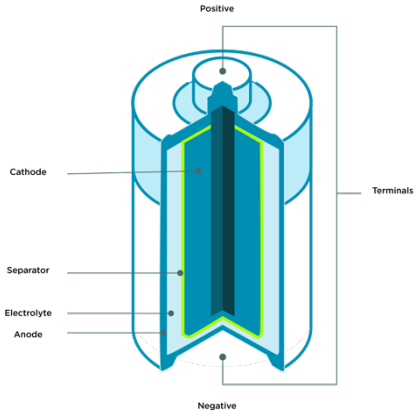

Figure 1. Key components of a battery.

An **anode** is a negative electrode[ii]. 'Electrode' just means a component where electricity enters or exits an object. The anode reacts with the electrolyte (the chemical substance that conducts electricity) to release electrons to the external circuit (the wires and device being powered)[iii]. This chemical reaction is called 'oxidation'. You can remember it using 'OIL'. Oxidation Is Loss of electrons.

A **cathode** is a positive electrode which reacts with the electrolyte to accept electrons from the external circuit[iv]. This chemical reaction is known as 'reduction'. You can remember it using 'RIG'. Reduction Is Gain of electrons.

Electrolyte is a chemical medium (liquid, gel or solid) that allows an electrical current to flow through it. It balances the movement of negative electrons by allowing movement of positive ions (a charged atom or molecule)[v].

Anodes, cathodes, and electrolytes come in a variety of chemical makeups. This is generally how batteries are defined, e.g., lithium-ion, nickel cadmium etc.

What's the charge?

Oxidation and reduction are the chemical reactions that make batteries work.

Both oxidation and reduction have 'standard potentials'. Standard potentials define the ability of anodes to release electrons, and the ability of cathodes to gain electrons[vi].

In a battery, the anode will have a lower standard potential and the cathode will have a higher standard potential.

This creates a push-and-pull of electrons from the anodes, out of the battery and through the conducting wire (connected to the device the battery is powering) and back into the cathode[vii]. This closes the circuit and keeps electrons flowing.

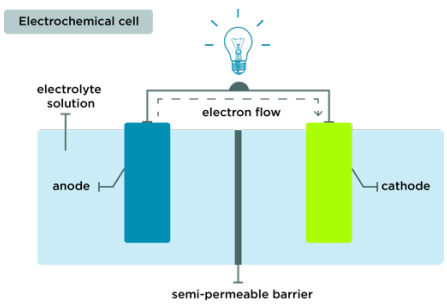

Figure 2. Flow of electrons from the anode to the device, to the cathode. Source: How a battery works, Australian Academy of Science

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The greater the difference between the standard potential of the anode and the cathode, the greater the battery's voltage[viii]. A higher voltage means more electrons flow through a circuit.

When several battery cells are stacked together in a certain way, the voltage can be increased. This happens, as the force of electrons moving from the anode of the first cell to the cathode of the last cell combines in an accumulated force. Larger batteries are often several smaller batteries stacked together

A simple experiment

A simple way to demonstrate how batteries work is the 'Lemon Battery' experiment. Common household materials act as the components of a battery, and a lemon is used as the electrolyte. You can find instructions for this experiment online.

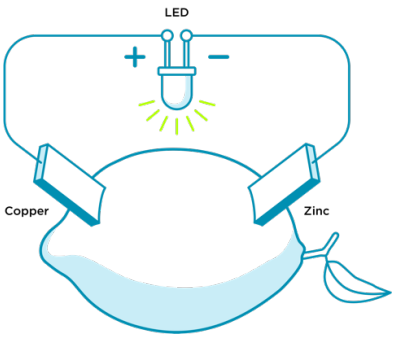

Figure 3. Lemon Battery

Recharge or recycle?

Primary batteries are single-use, and secondary batteries are rechargeable.

Primary batteries have a limited number of electrons, which are depleted with use. When this happens, batteries are often referred to as 'dead' or 'flat' and should be recycled.

Secondary batteries can be recharged by connecting them to a power source. This reverses the chemical reaction that occurred during use, and 'refills' the battery.

Table 1. Common chemistries of primary batteries

Chemistry	Uses
Alkaline	Consumer devices
Lithium iron disulfide ($LifeS_2$)	Alternative to alkaline
Lithium-thionyl chloride ($LiSOCl_2$ or LTC)	Fracking
Lithium manganese dioxide ($LiMnO_2$ or Li-M)	Medical devices, road toll sensors, smoke alarms
Lithium sulfur dioxide ($LiSo_2$)	Defense systems

Table 2. Common chemistries of secondary batteries[ix].

Chemistry	Uses
Lead-acid	Car batteries, UPS
Nickel-cadmium (NiCd)	Power tools, aviation, medical devices
Nickel-metal-hydride (NiMH)	Medical devices, hybrid cars
Lithium-ion (several types)	Mobile phones, laptops

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References

i. Bhatt, A., Forsyth, M., Withers, R., & Wang, G., 2016, How a battery works, Australian Academy of Science, accessed 21 January 2022, <https://www.science.org.au/curious/technology-future/batteries>, last updated: 25 February 2016.
ii. An 'electrode' is a solid conductor that facilitates the movement of electrical currents.
iii. Ibid, 1
iv. Ibid, 1
v. Ibid, 1
vi. Ibid, 1
vii. Ibid, 1
viii. Ibid, 1
ix. Isidor Buchmann 2017, BU-107: Comparison Table of Secondary Batteries, Battery University, accessed: 21 January 2022, <https://batteryuniversity.com/article/bu-107-comparison-table-of-secondary-batteries>, last updated: 21 October 2021.

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