Inside a Battery

You may use them every day, but do you know what makes them work?

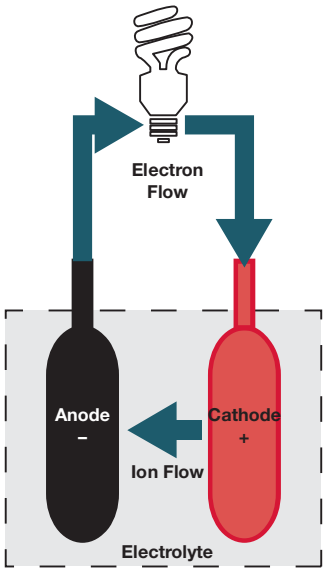
Batteries are energy storage devices that use electrochemical reactions to make direct-current electricity.

You may already be familiar with common types, such as alkaline batteries used in consumer devices; lithium-ion and nickel-metal hydride technology in cordless tools; and deep-cycle flooded lead-acid batteries for energy storage in renewable energy applications. The difference between them lies in their chemistries—different combinations of chemicals lend themselves to certain applications. Non-rechargeable alkaline batteries have been the low-cost solution for many portable needs. Lithium-ion batteries offer a powerful lightweight solution for rechargeable appliances like cordless tools. Deep-cycle lead-acid batteries deliver electricity over a long period of time. But what's behind a battery's energy-producing capabilities?

A battery cell has three main components: the anode, the cathode, and the electrolyte. The anode loses electrons and the cathode accepts electrons. The electrolyte is a solution that allows charged ions to move between the anode and cathode. Batteries are often comprised of multiple cells in series (for example, a 6 V lead-acid battery will have three cells). Within a battery's individual cells, the anode and cathode are physically separated, but surrounded by the electrolyte.

These components are housed in a plastic case, with accessible negative and positive terminals or posts. The negative terminal functions as the anode during discharge, while the positive terminal is the cathode. In a lead-acid battery, for example, the anode is a lead plate and the cathode is a lead-dioxide plate. A sulfuric acid and water solution is the electrolyte.

Battery Cell



When a battery cell is discharging, electrons flow from the negative terminal, through the load, back to the positive terminal.

Inside a Flooded Lead-Acid Battery

An electrochemical reaction takes place when there is a reason for electrons to move. Connecting a load (a light bulb, for instance) to a battery completes the circuit causing the electrochemical reaction to take place by "pulling" electrons out of storage. The resulting reaction moves electrons from the negative anode through the bulb, illuminating it. The electrons continue through the circuit to the positively charged cathode. The electrolyte completes the circuit by allowing a path for negatively charged ions to move back to the anode. As the cell discharges, lead sulfate forms on both plates and the ratio of water to sulfuric acid increases in the electrolytic solution, thus depleting the storage in the battery.

In recharging, the reverse reaction takes place. The positive terminal now gives up electrons and functions as the anode, while the negative terminal accepts electrons as the cathode. Like all energy transformations, there are losses in the conversion process (chemical to electrical and back again). While batteries are charging or discharging, some heat may be released. The lead-acid battery charging process also releases hydrogen gas.

A disposable, non-rechargeable battery does not need input to produce electricity as it comes in a fully charged state. Eventually, the battery and its electrolyte will exhaust its capacity to move ions.

—Erika Weliczko