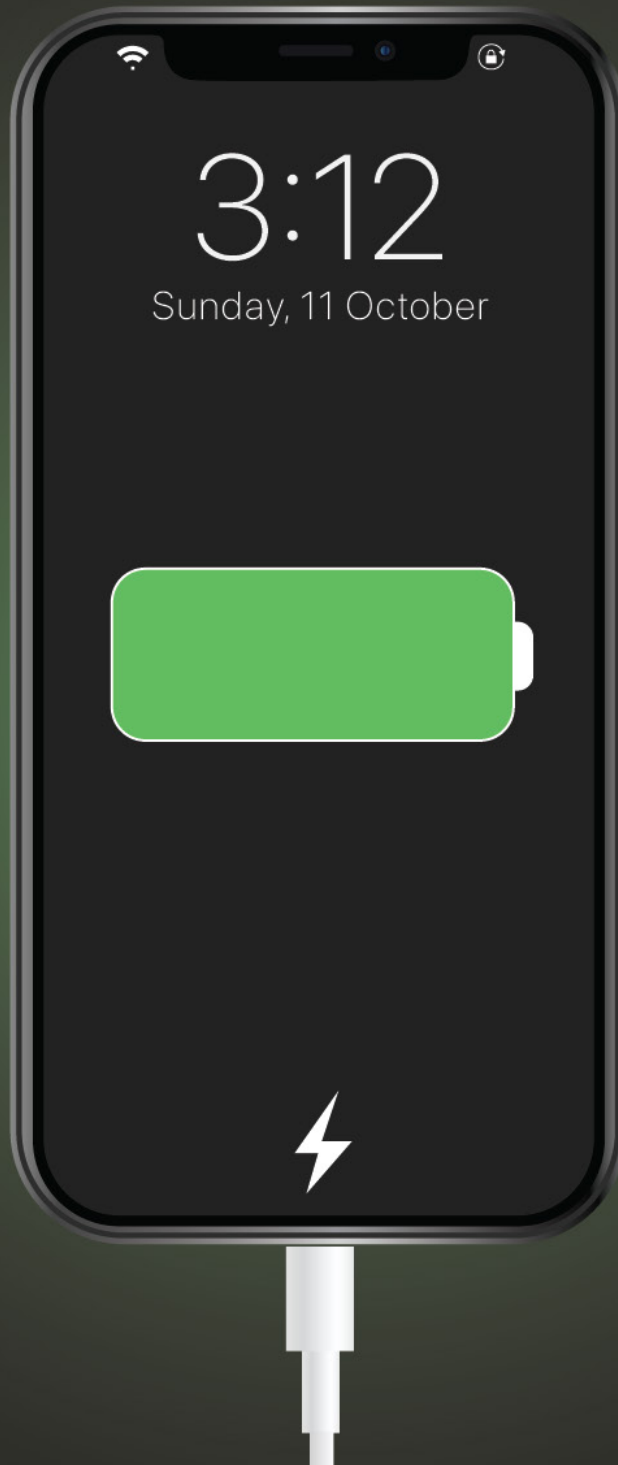


Elena Capeska & Sopphira Tang

Battery Life

The life of the battery is just as important
as the life of the iPhone.



Battery Life of the iPhone

Elena Capeska & Sopphira Tang



Apple iPhone batteries use **lithium-ion technology**. Research has shown that lithium-ion batteries charge faster, last longer and have high power density which allows longer battery life in a smaller and lighter package.

The **cathode** determines the capacity and voltage of a Li-ion battery. It generates electricity through the chemical reactions of lithium, which is inserted into the battery. The space made for the lithium is called cathode. However, lithium is unstable in the element form. The combination of lithium and oxygen, lithium oxide is used for the cathode. The material that intervenes the electrode reaction of the battery like the lithium oxide is called active material. The cathode plays an important role in determining the characteristics of and the voltage of the battery.

An **anode** sends electrons through a wire. It is a substrate that is also an active material. Its role of enabling an electric current flow through the external circuit allows a reversible absorption of lithium ions which are released from the cathode.

When the battery is put under load, the anode releases electrons to the negative terminal and ions in the electrolyte through an oxidation reaction. The cathode accepts these electrons, completing the circuit for the flow of electrons.

Electrolytes allows the movement of the ions only. They serve as a medium that enables the movement of only lithium ions between the cathode and the anode. The electrolyte consists of materials with high ionic conductivity and is mainly used so that lithium ions move back and forth easily. It is composed of salts, solvents and additives. The salts serve as a passage for the lithium ions to move while the solvents are organic liquids used to dissolve the salts, and the additives are added in small amounts for specific purposes. In addition, the movement speed of lithium ions depends on the electrolyte type. Therefore only electrolytes that meet strict requirements can be used.

While the cathode and anode determine the basic performance compatibility of a battery

the electrolyte and separator determine the safety of a lithium-ion battery.

The **separator** is the absolute barrier between cathode and anode. It functions as a physical barrier keeping cathode and anode apart. The separator prevents the direct flow of electrons and carefully let's only the ions pass through the internal microscopic hole. Thus, it must meet all the physical and electrochemical conditions. Commercialized separators we have available today are synthetic resins such as polyethylene (PE) and polypropylene (PP).

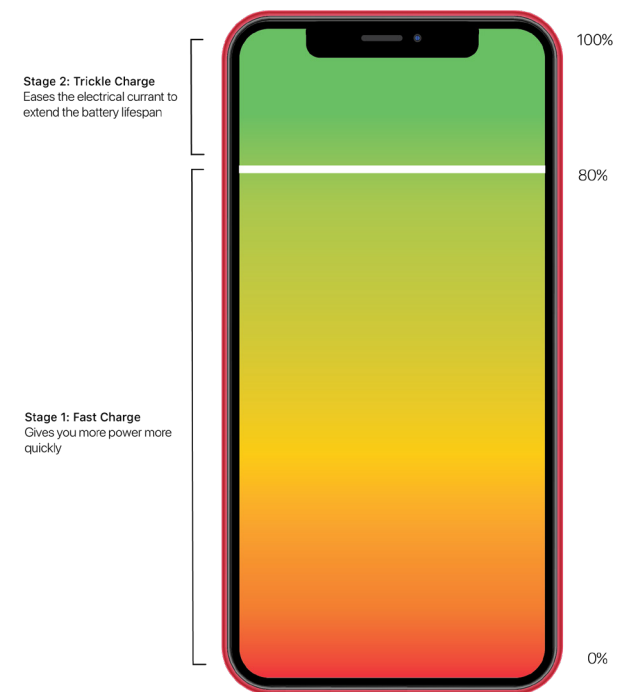
The batteries work in **charge cycles**. The cycles work when the user uses up (discharges) an amount that equals 100% of the battery's capacity, this amounts to one cycle being complete. The discharge can not necessarily be all from one charge. Apple lithium-ion batteries are designed to hold a minimum 80% of their original capacity charge for a higher amount of charge cycles available. They use **fast charging** to quickly reach 80% of the battery's capacity, then switch to slower

trickle charging. This process allows battery life to be extended.

With this type of battery, the capacity of the battery diminishes slightly with each complete charge cycle. Different types of software used can limit charging above 80% when the recommended battery premature are exceeded.

It is important to distinguish between **battery life** and **battery lifespan**. Both are key to allowing an iPhone to last a long time. While battery life is the amount of time an iPhone lasts until it needs to be charged again, battery lifespan is more concerned with the replacement of an iPhone's battery. To sustain battery lifespan, consider: updating to the latest software, avoiding use or charge in extreme temperatures, removing certain cases that generate excess heat, charging to 50%, powering down when not in use and never fully wasting its battery. Easy ways to maximise battery life include: using auto brightness, connecting to wi-fi instead of a mobile network, enabling aeroplane or low power mode and charging via computer.

iPhone Charging Stages



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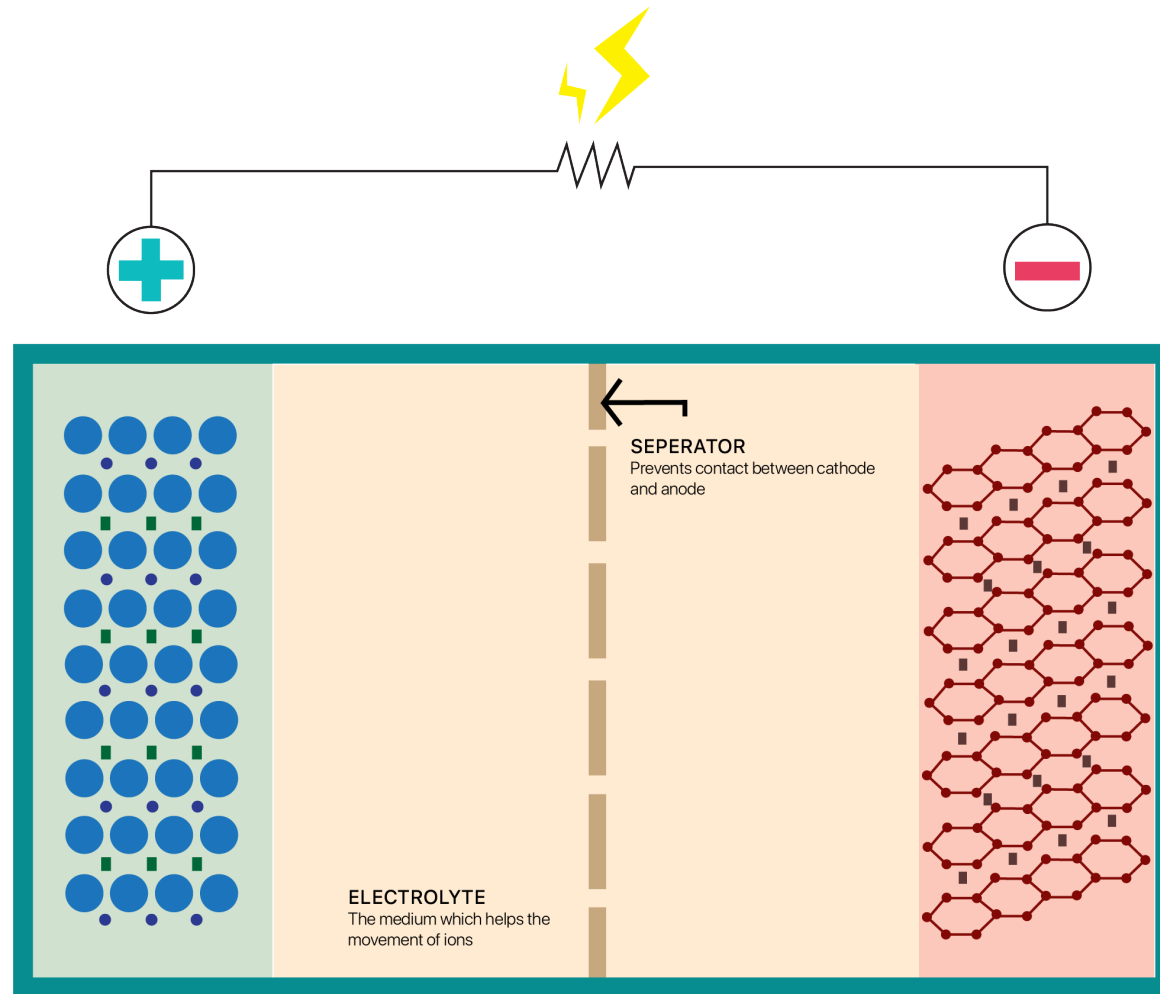
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Four Components of a Li-ion Battery



Cathode

As the source of lithium ions, determines the capacity and the average voltage of a battery.

Anode

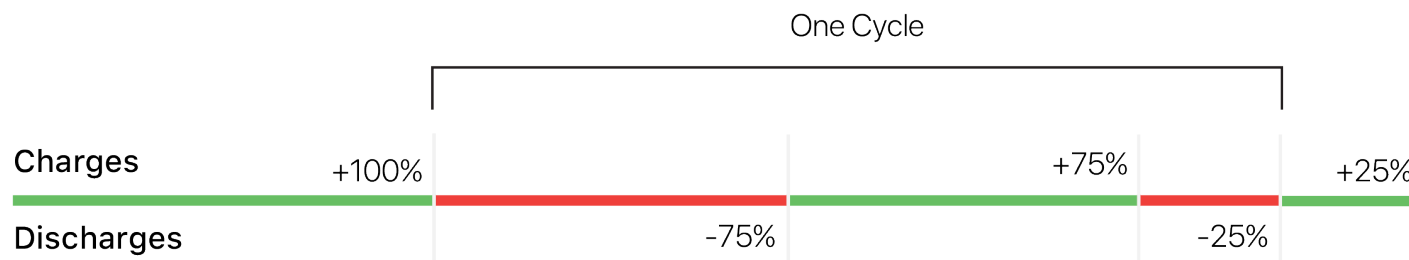
Stores and releases the lithium ions from the cathode, allowing the pass of currents though an external circuit.

iPhone, iPad, iPod and Apple Watch Comfort Zone



iPhone, iPad, iPod and Apple Watch work best at 0° to 35° C (32° to 95° F) ambient temperatures.
storage temperature: -20° to 45° C (-4° to 113° F)

Battery Charging Cycle



One charge cycle is completed after you've discharged 100 per cent of your battery's capacity

iPhone Battery Life Drain Test

