canal

Using Charging Intervals to Extend Battery Life

Making the case with experimental data that taking more time to recharge can pay big dividends

The Problem

Rechargeable batteries are used in many devices including mobile phones, laptops, tablets, power tools, and automobiles to name a few. It's well-known that batteries do not last forever, but instead of attempting to mitigate the damage, the current trend in the electronics industry is towards faster and faster charging. While this is convenient for the user on-the-go, fast charging accelerates battery decay by significantly boosting power delivery and battery temperature, thus decreasing the overall capacity and lifespan of the battery.

Eventually, the consumer is faced with little choice but to purchase an expensive replacement device or battery. The more the device is worth, the more likely the user will pay to purchase another expensive battery. To make matters worse, batteries are environmentally costly to produce and to dispose of as electronic waste. It is ultimately in both the private and public sector's best interest to extend the lifespan of batteries.

The Solution

We propose a new method of charging, one where the charging process is spread out over a user-defined period of time, and breaks are given to allow the battery to "rest" and cool down.

To test this new method, we're currently running an experiment on two groups of smartphones: a control group charging conventionally, and an experimental group charging with our proprietary algorithm. The following graph is from preliminary results:

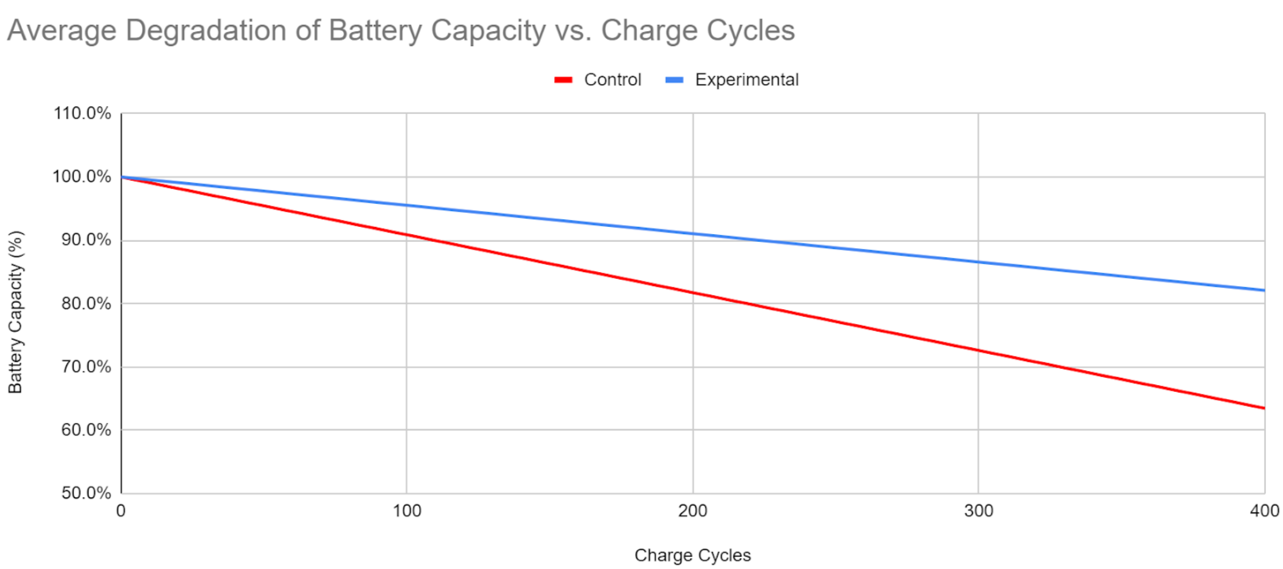


Figure 1. Battery capacity loss over time with conventional charging vs. Canal's proprietary algorithm (see Appendix A and B for experimental data)

The results of the experiment so far paint a clear picture: conventional charging degraded the smartphone batteries at twice the rate compared to Canal's algorithm. The implications for this technology are huge. Consumers can enjoy more daily battery life in the short-term and keep their device for longer if they choose. In addition, with fewer batteries and devices needing to be bought as replacements, we can reduce the environmental cost of battery production and electronic waste.

Experimental Methods

The hypothesis behind our experiment was simple: giving batteries rest period in between charging can extend the overall lifespan of the battery.

10 Blu smartphones (model C775443200L) with a 2000mAh capacity rechargeable lithium-ion battery were put into the control group, and 10 were put into the experimental group. All the phones were plugged into a 5V/1A wall charger, with a Battery Guard placed in between the charger and the charging cable. The Battery Guard (see www.canalbatteryguard.com for explanation of the device) served to modulate the charging in the case of the experimental group, and to discharge the phones in both groups.

The phones in the control group were discharged to 15%, then charged straight to 100%, paused charging for 8 hours to simulate how typical overnight phone charging occurs, and then repeated the process (see Figure 2 for flow diagram). This process was considered as one charge cycle.

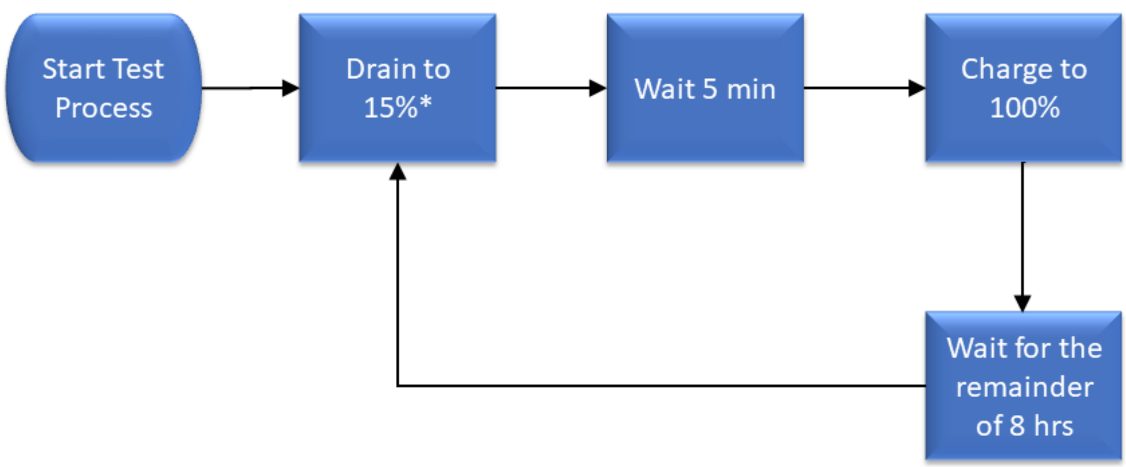


Figure 2. Control group charge cycle

*Note: Draining/discharging the phones was achieved by loading the CPU, continually attempting to update the GPS location, and toggling the LED flash of the device.

The phones in the experimental group were discharged to 15% and then charged in 30 second intervals alternated with non-charging intervals** until fully charged (see Figure 3 for flow diagram). This process was considered as one charge cycle.

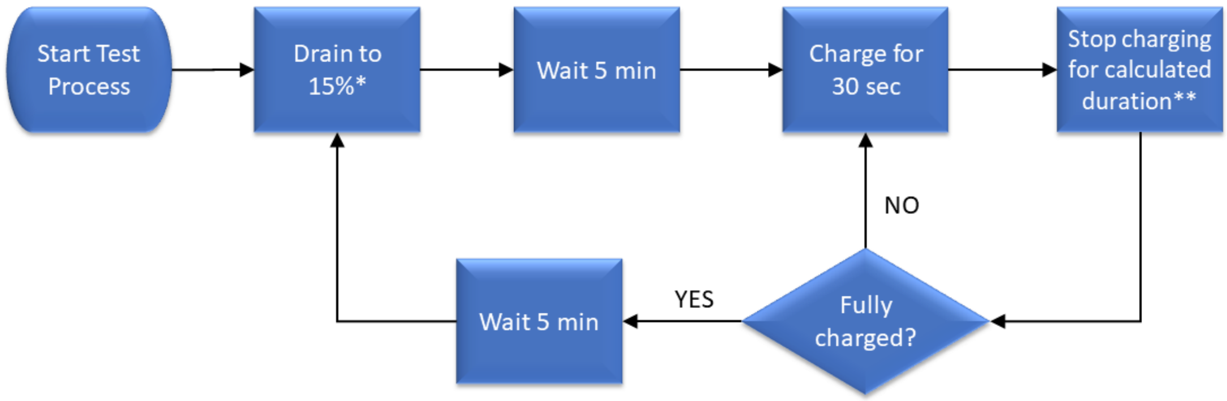


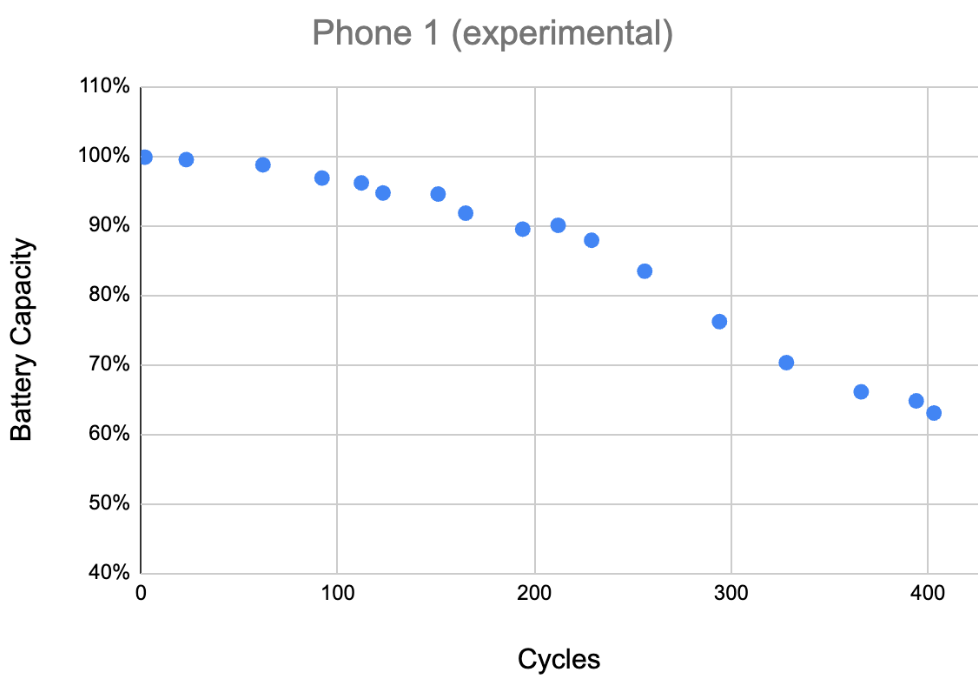
Figure 3. Experimental group charge cycle

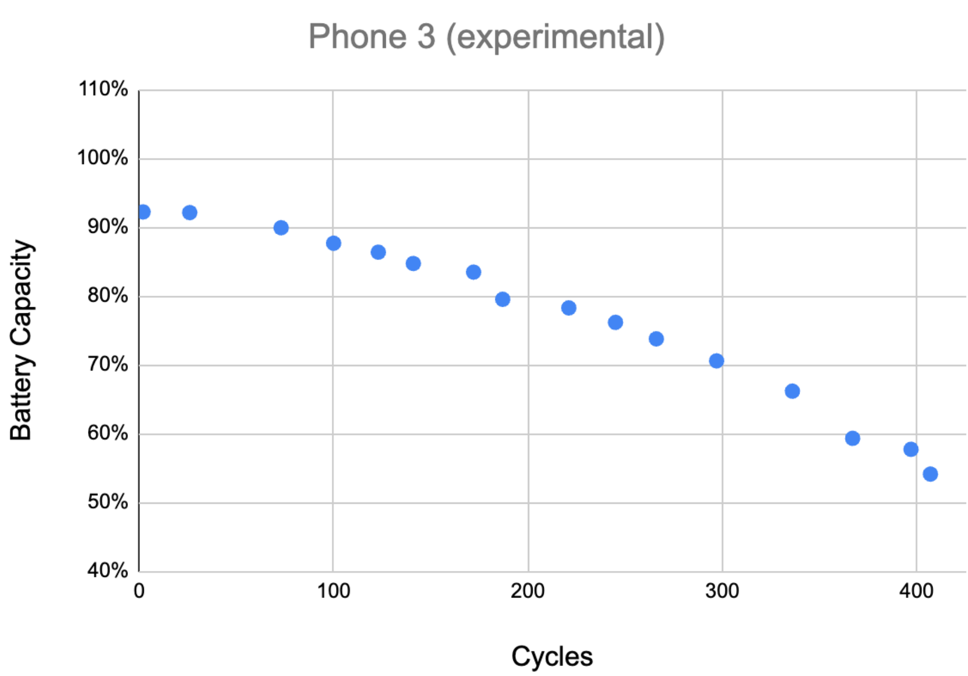
**The non-charging interval is dependent on charge rate and battery capacity, and is calculated to spread the charge out across 8 hours to mimic a typical overnight charging time window.

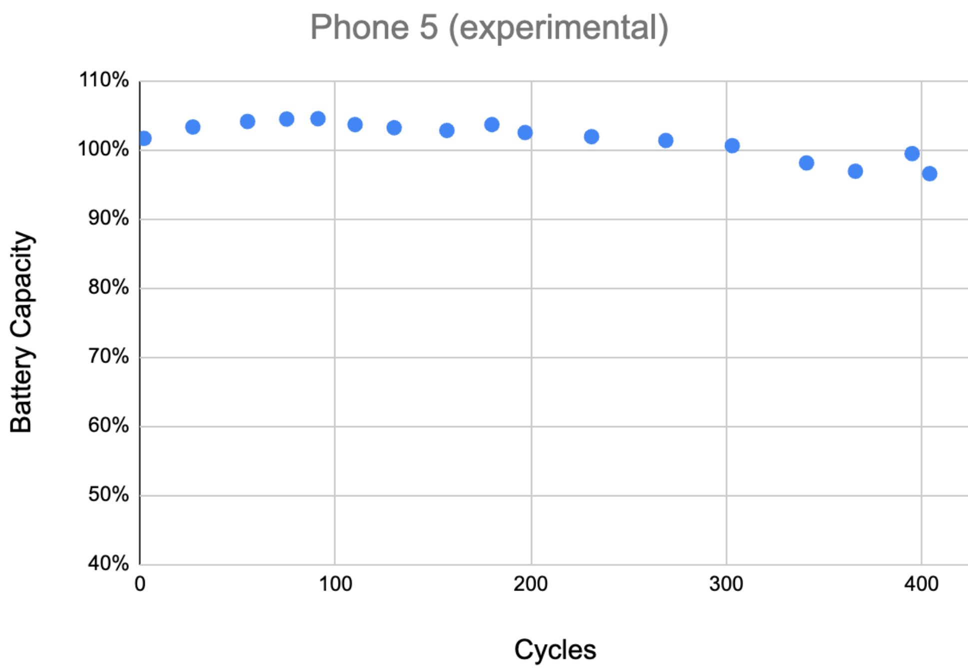
An app called AccuBattery was used to measure the capacity of the battery before the experiment and at time intervals throughout the experiment to get data points. AccuBattery continuously reads the battery current measurement provided by the Android OS and uses these measurements to determine how much charge enters the battery over time. Once the phone charges from near 0% to 100%, AccuBattery calculates the total charge that entered the battery in mAh giving the total battery capacity at that time.

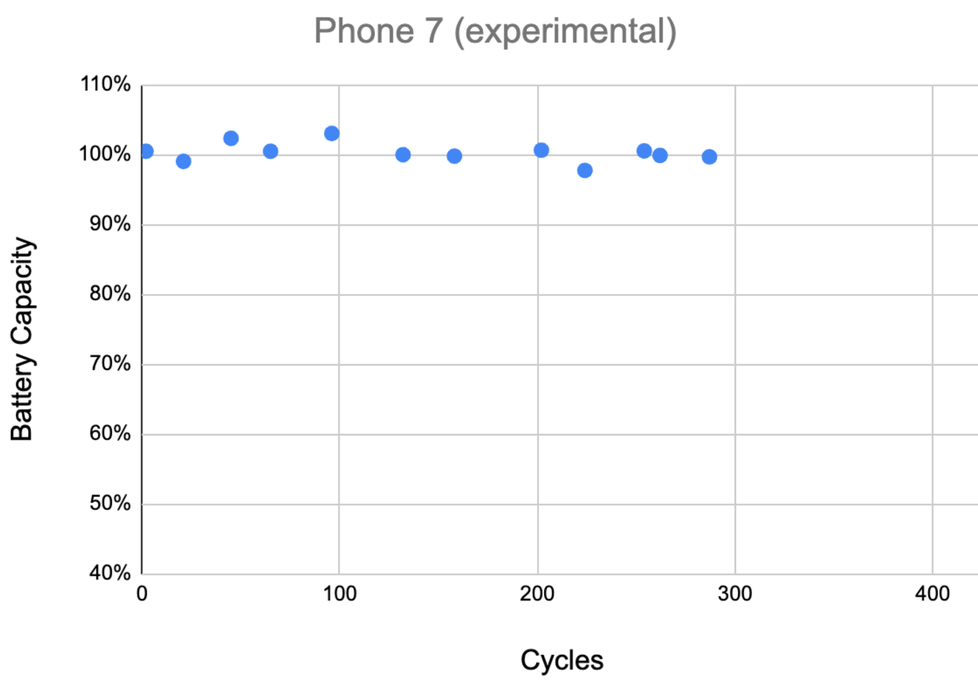
Appendix A - Preliminary Individual Phone Data

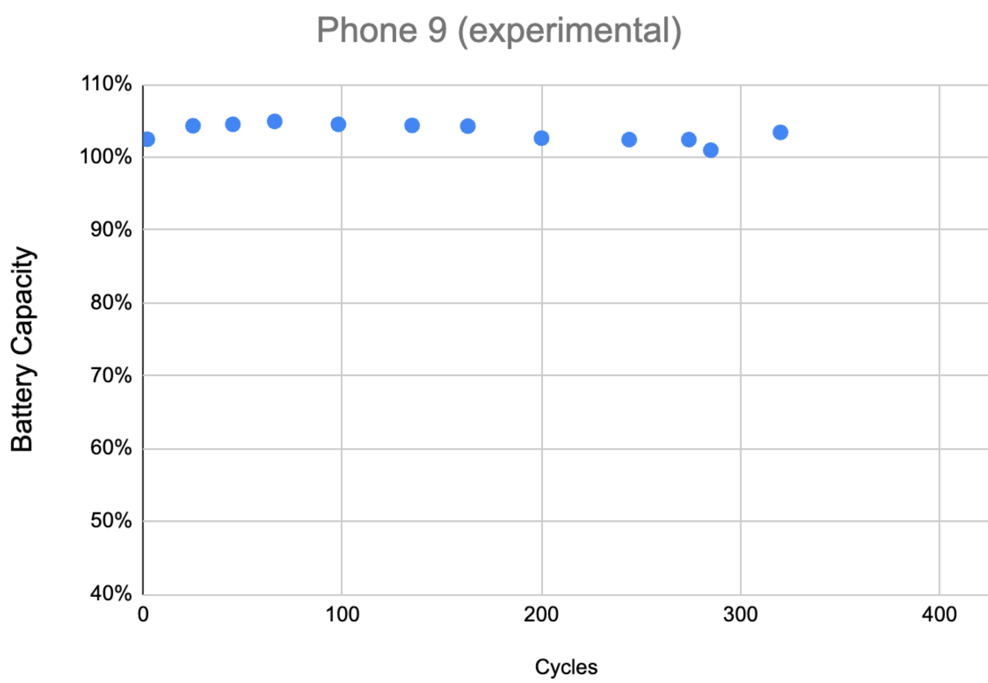
Experimental Group





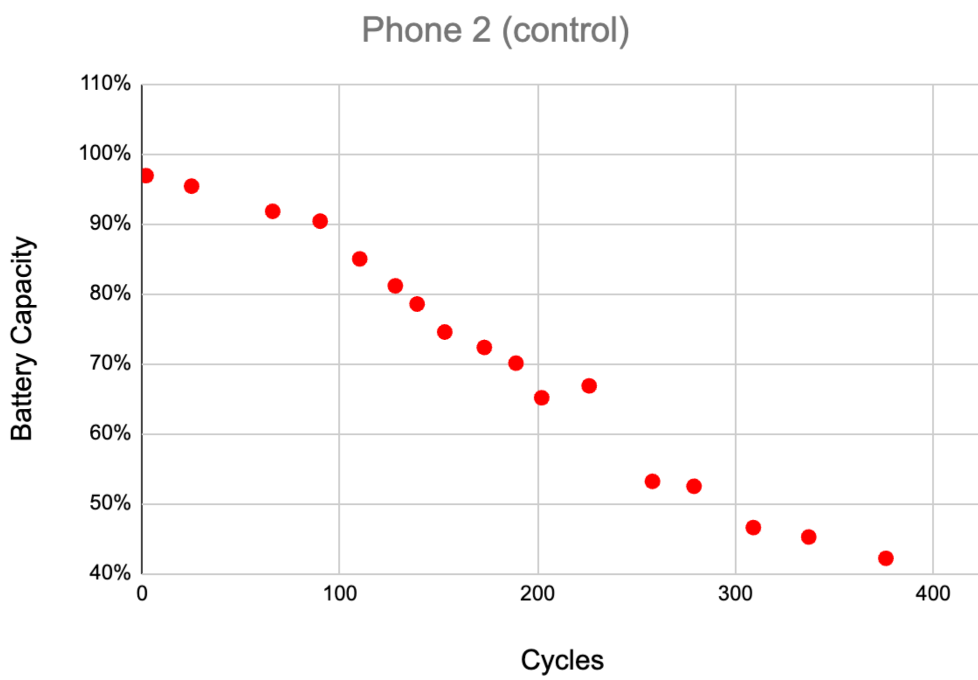

Phone 5 (experimental)
110%
100%
90%
80%
70%
60%
50%
40%
Battery Capacity
0
100
200
300
400
Cycles

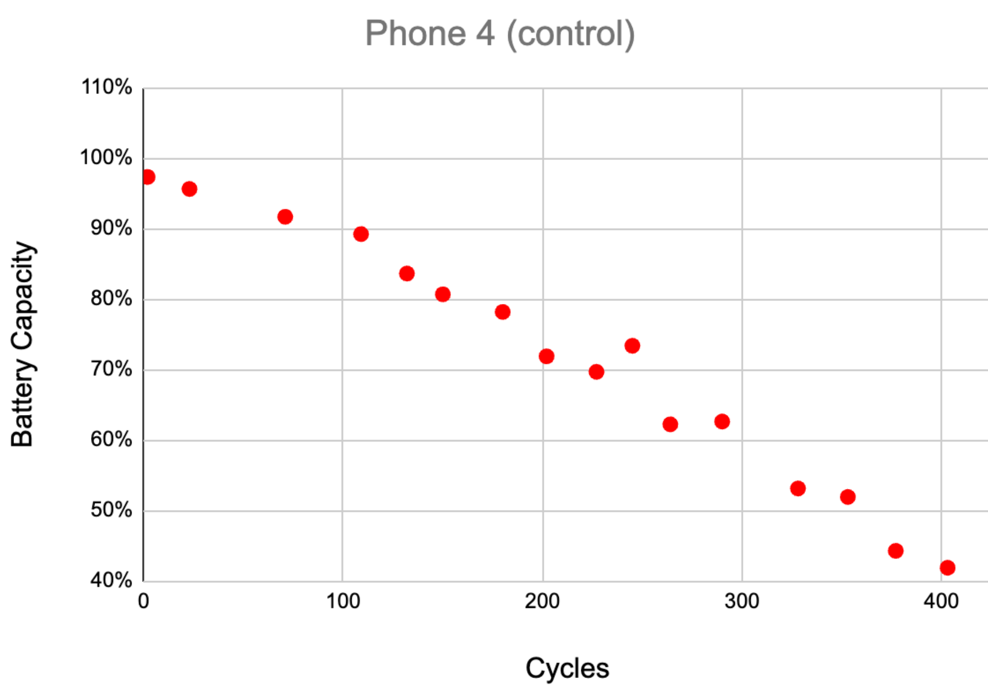

Phone 7 (experimental)
110%
100%
90%
80%
70%
60%
50%
40%
Battery Capacity
0
100
200
300
400
Cycles

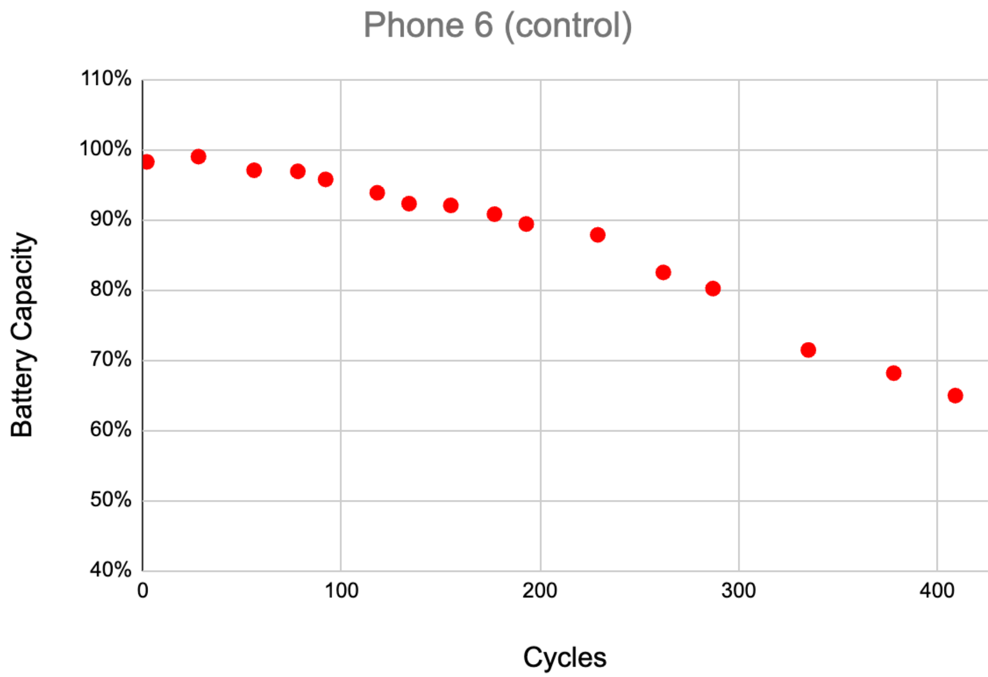


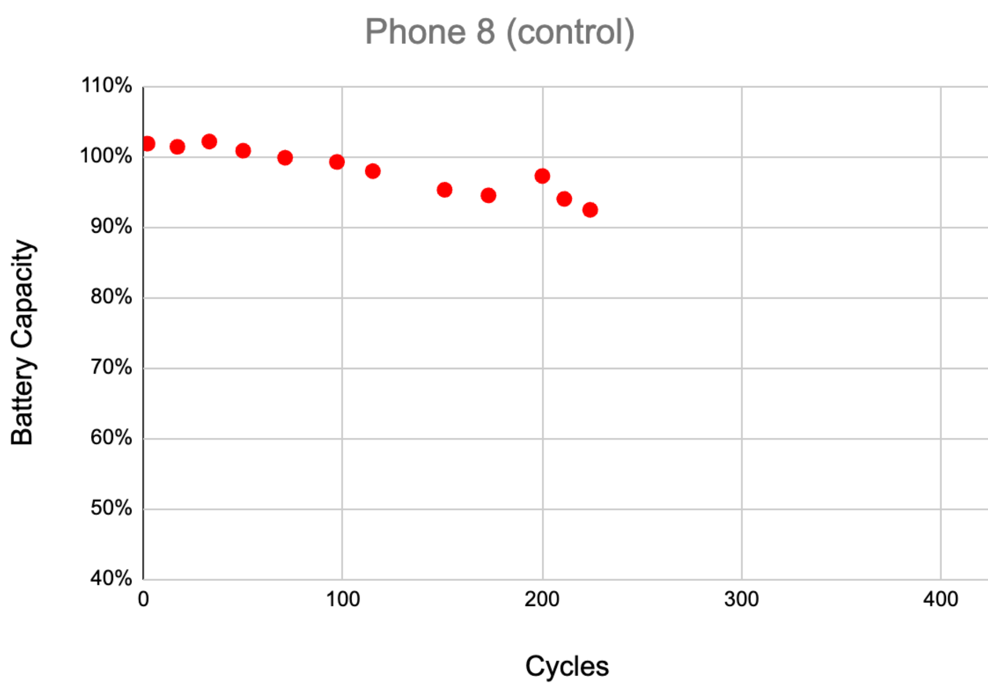
Phone 9 (experimental)
Battery Capacity
110%
100%
90%
80%
70%
60%
50%
40%
0
100
200
300
400
Cycles

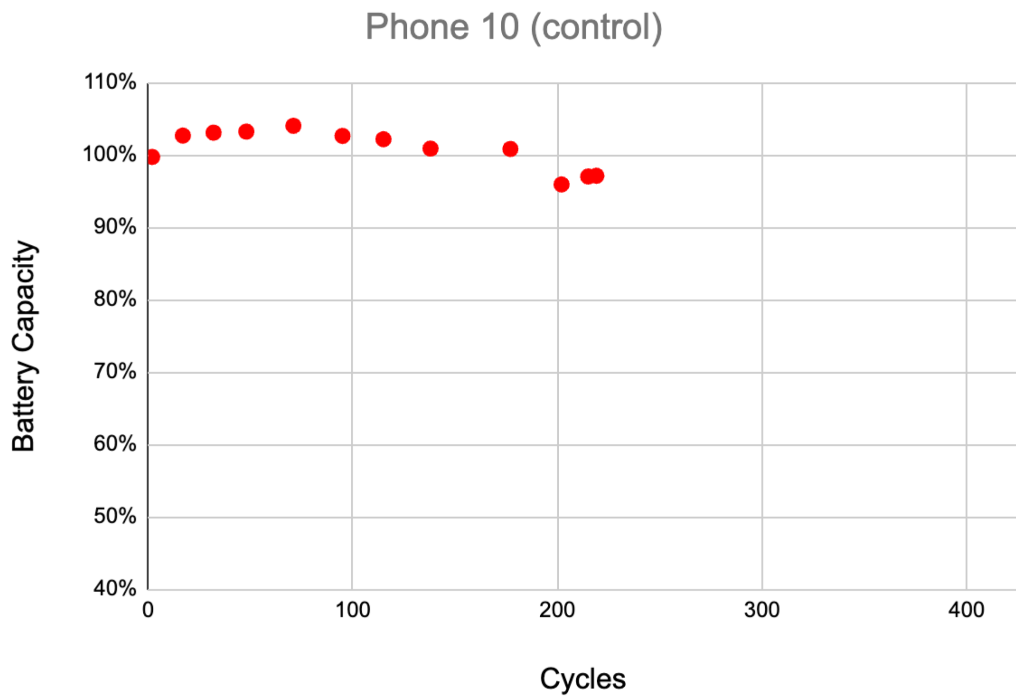
Control Group






Phone 6 (control)
Battery Capacity
110%
100%
90%
80%
70%
60%
50%
40%
0
100
200
300
400
Cycles


Phone 8 (control)
Battery Capacity
110%
100%
90%
80%
70%
60%
50%
40%
0
100
200
300
400
Cycles


Phone 10 (control)
Battery Capacity
110%
100%
90%
80%
70%
60%
50%
40%
0
100
200
300
400
Cycles