adafruit learning system

Circuit Playground: B is for Battery

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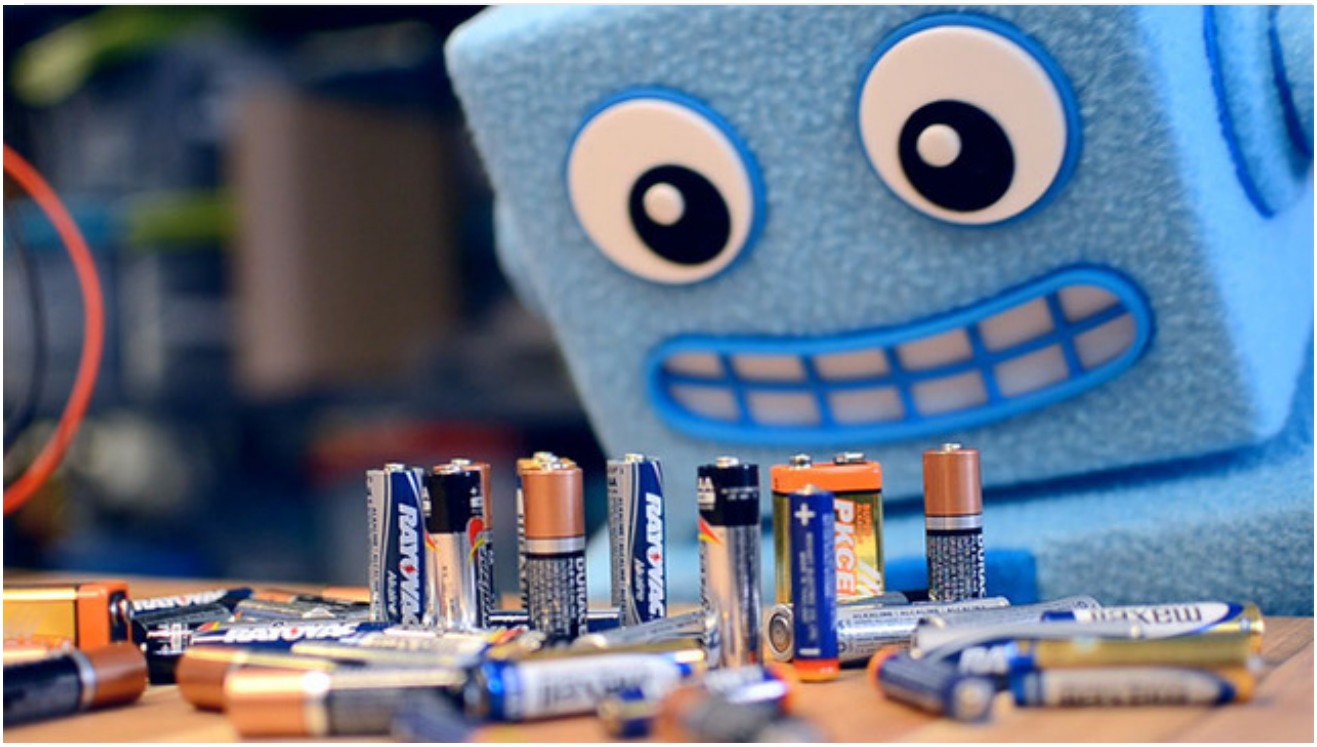
Guide Contents

Video

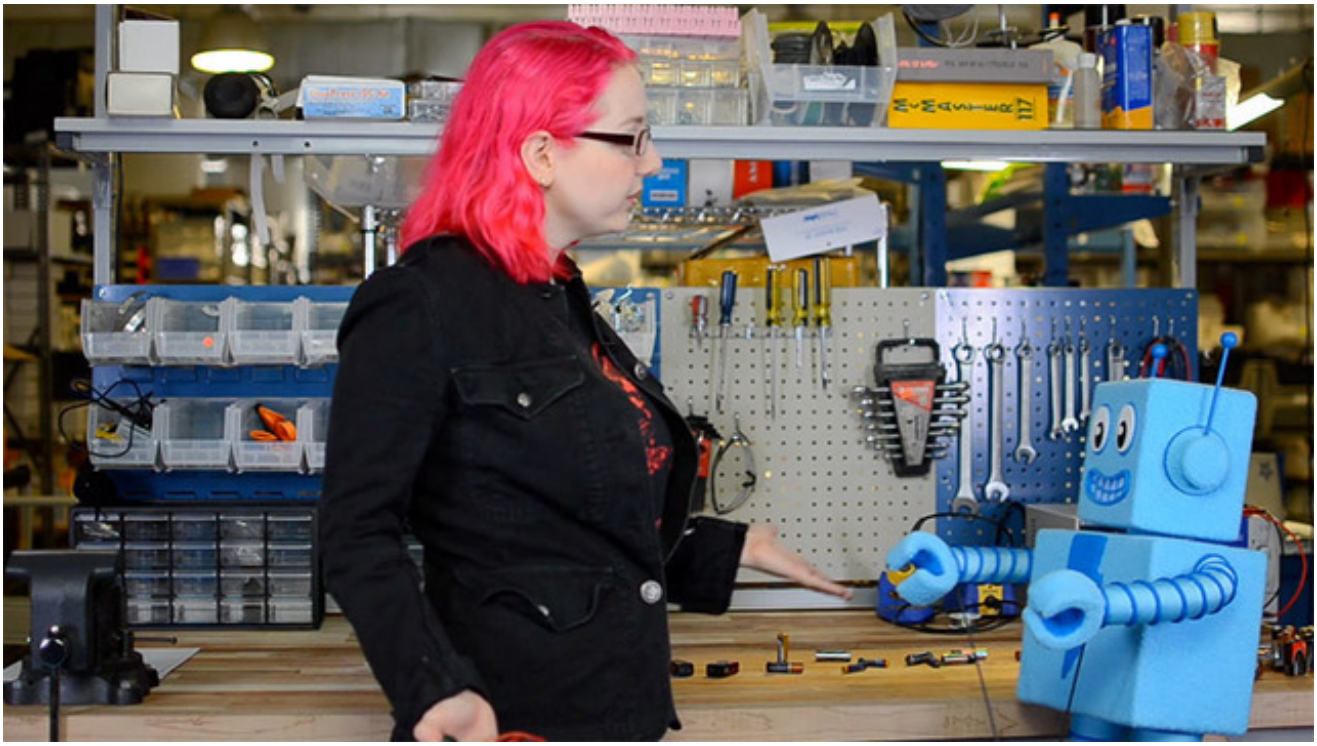
"B is for Battery" - Circuit Playground Episode 2! Learn all about electronics and how to make a lemon battery with Ladyada and ADABOT!

Learn more: http://www.adafruit.com/coloringbook (http://adafru.it/cc6)

Transcript

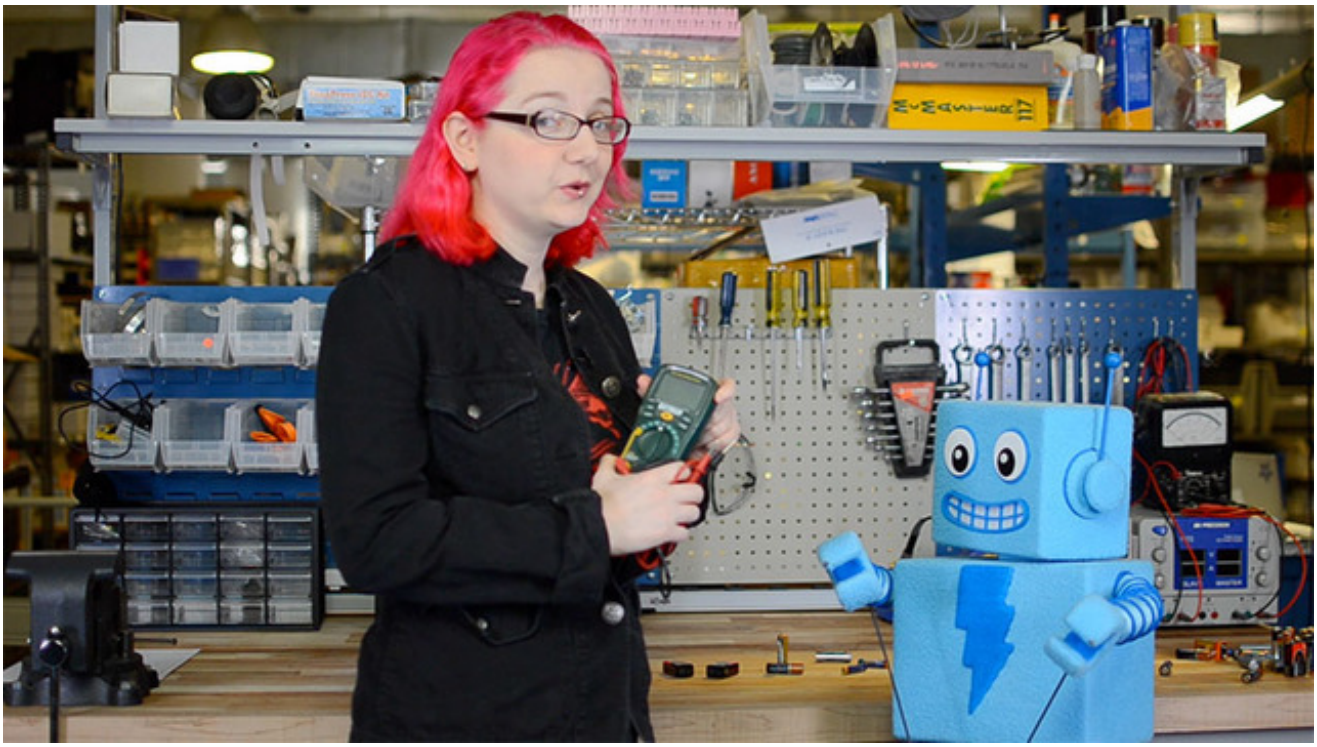


Adabot: Woooowwww ...



Ladyada: Hey Adabot - did you see any of my AA batteries arou -- ?

Adabot: Oh hi Ladyada - I was just thinking about all the energy is stored in these batteries … just waiting to be used! … [tilts heads, mesmerized]



Ladyada: Yah … batteries are pretty cool …

Ladyada: … and they're even better when I use them to power my multimeter

Adabot: Affirmative - batteries allow us to use electricity on-the-go, without needing to plug into a wall socket. Very handy … But there is one thing I don't quite understand.

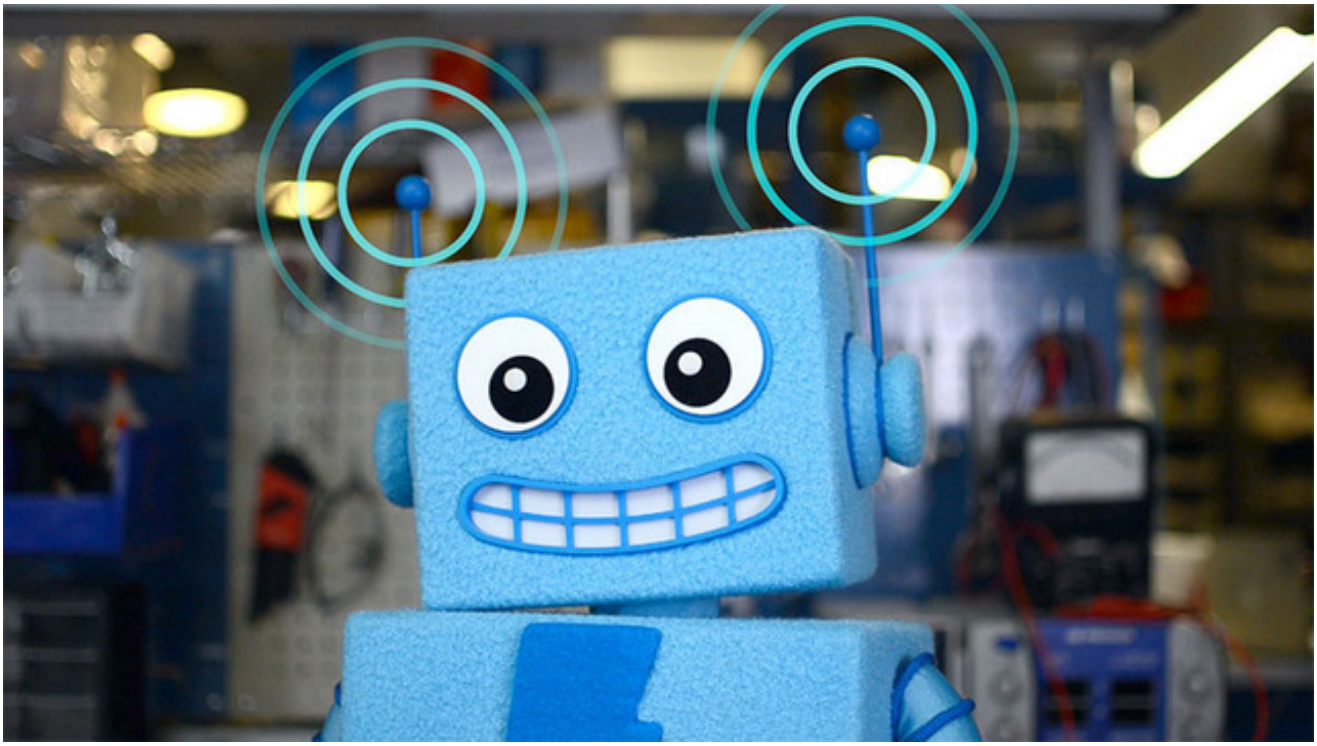
Ladyada: Oh? what's that?

Adabot: Ladyada how *are* batteries filled with electricity in the first place?

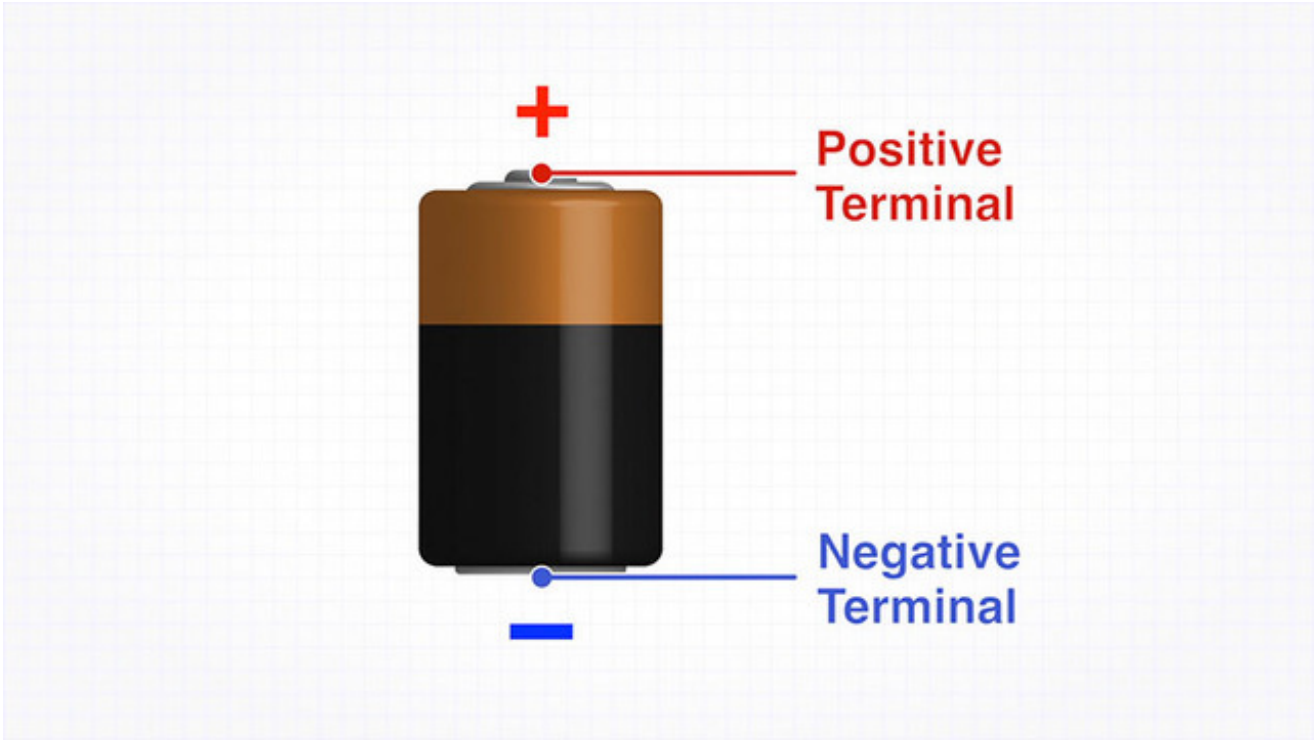
Ladyada: Well batteries aren't exactly filled with electrical energy, they're filled with a few different things that work together to *create* electrical energy.

Adabot: Wow - you mean like little machines inside that generate electricity?

Ladyada: Umm ... sort of ... I think we better look this one up.



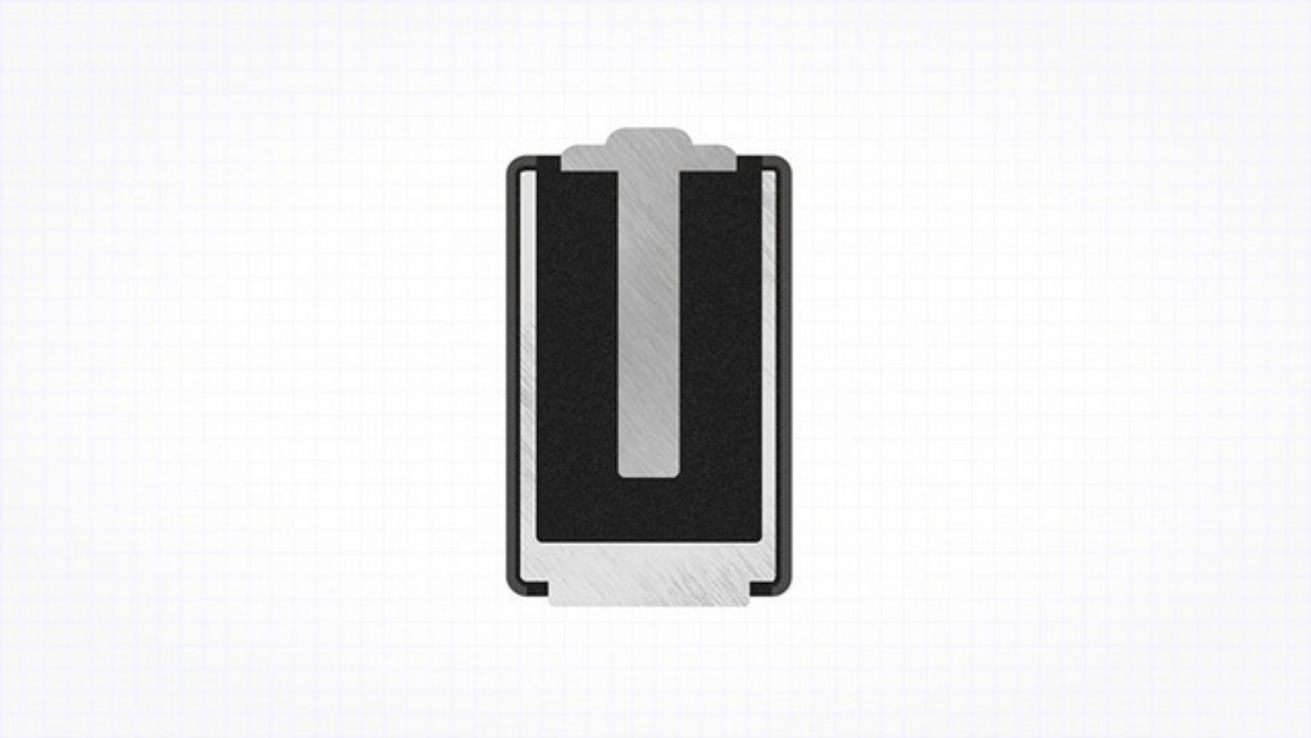
Adabot: Agreed! Accessing database “batteries”!



Ladyada: Thanks, Adabot. There are 2 important parts of a battery - the positive … & negative terminals. Connecting these 2 points to a circuit allows electrical current to flow from one terminal to the other

Adabot: Current, which we measure in amperes!

Ladyada: Exactly. And if we looked inside of a battery, we'd see something like this ...

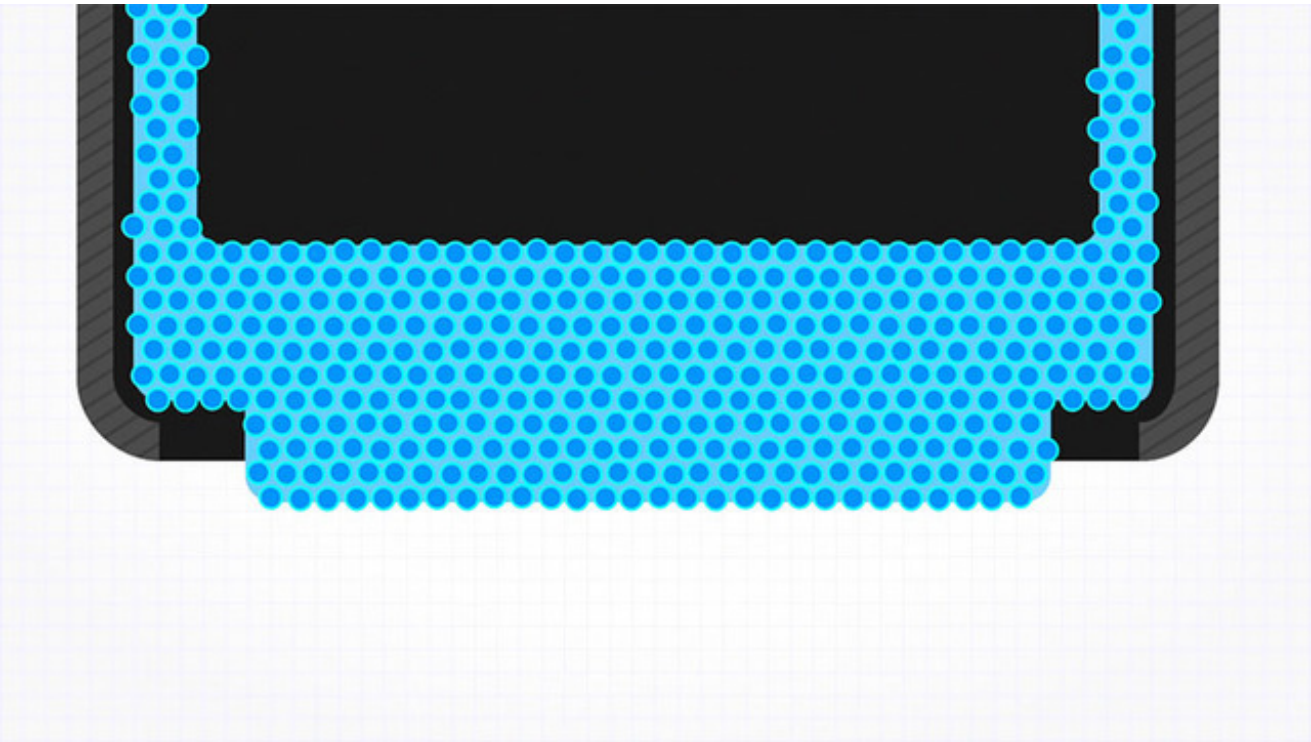


Adabot: Huh - how does that make electricity?

Ladyada: Well a battery uses *chemistry* to produce electricity - we call it an electro--chemical reaction.

Adabot: Ooh - sounds powerful!

Ladyada: It definitely is. Each terminal is connected to a different kind of material inside the battery. The material connected to the negative terminal has *lots* of extra electrons.

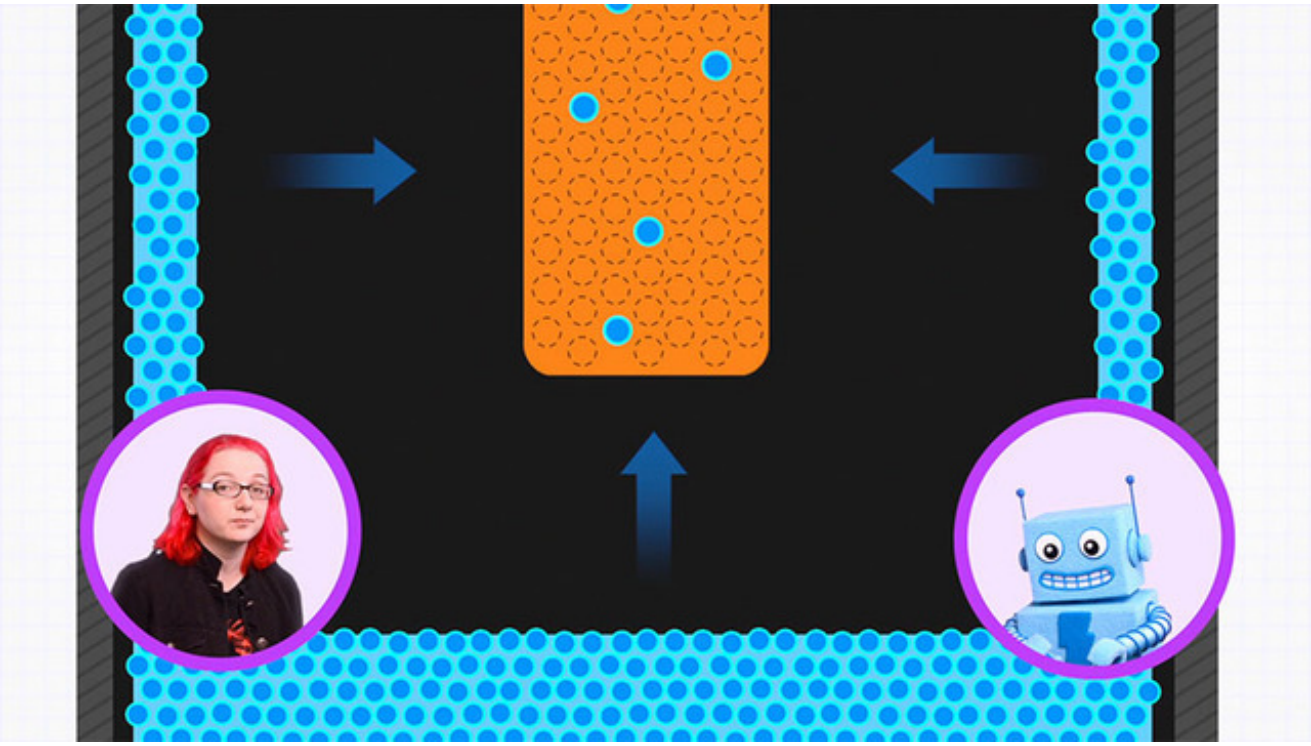


Adabot: looks pretty crowded in there!

Ladyada: Yup - it’s so crowded, that those electrons all want to go somewhere with more space for them to move around in.

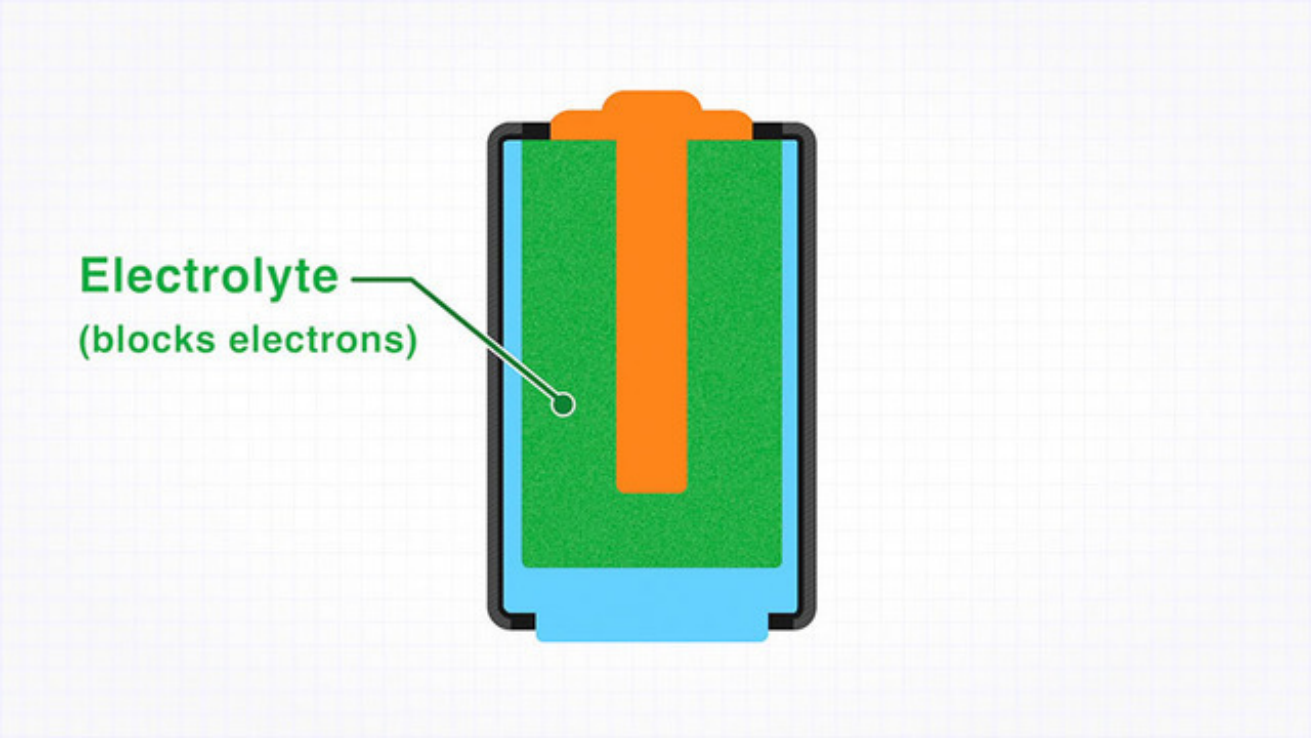
Ladyada: Lucky for them, the positive terminal has lots of empty spaces for more electrons to fit into.

Adabot: Oh - so why don’t they jump over to the positive terminal with all those empty spots?



Ladyada: They can't do that because the battery is filled with a special chemical called an electrolyte.

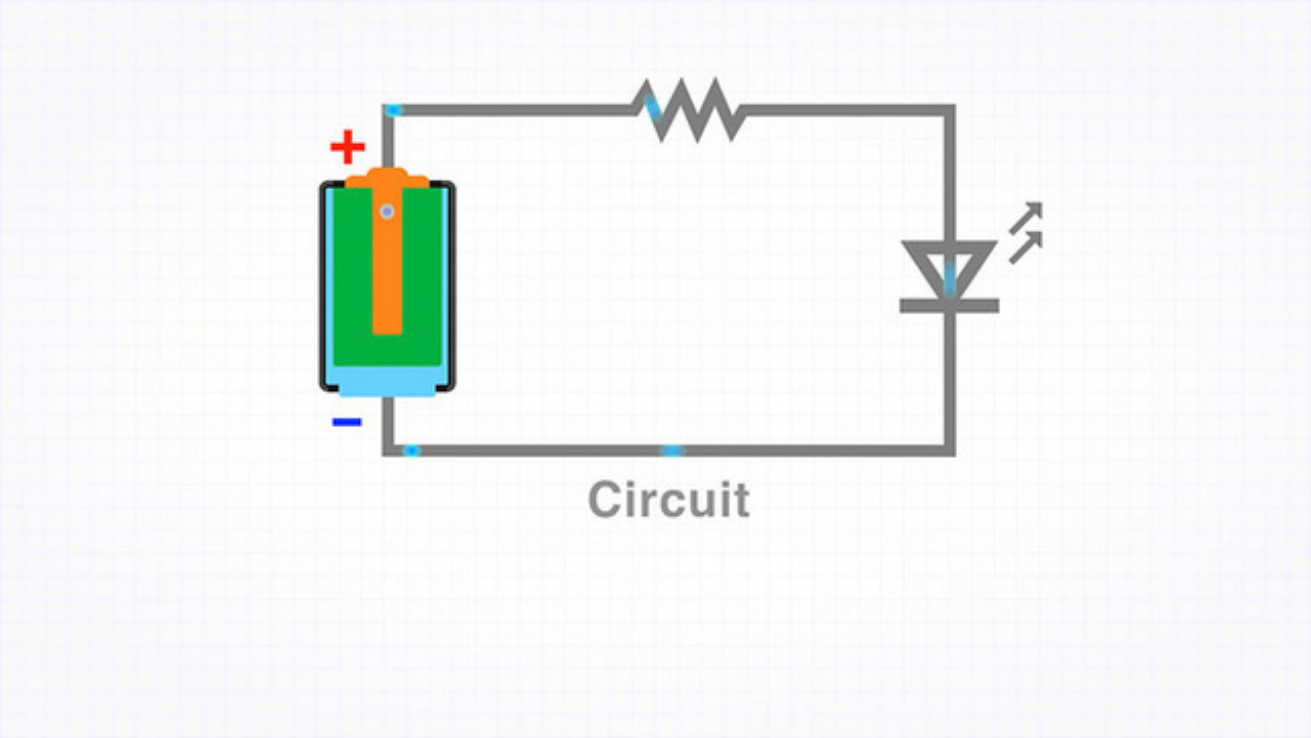
Ladyada: And electrons have a really hard time trying to move through electrolytes.



Adabot: That sounds awful! -- If they can't move through the electrolyte, how will they ever

get to their new homes over on the positive terminal?

Ladyada: By travelling through a circuit! When we connect a circuit to both terminals of a battery we give electrons a new way to get to those nice open spots over on the positive terminal.

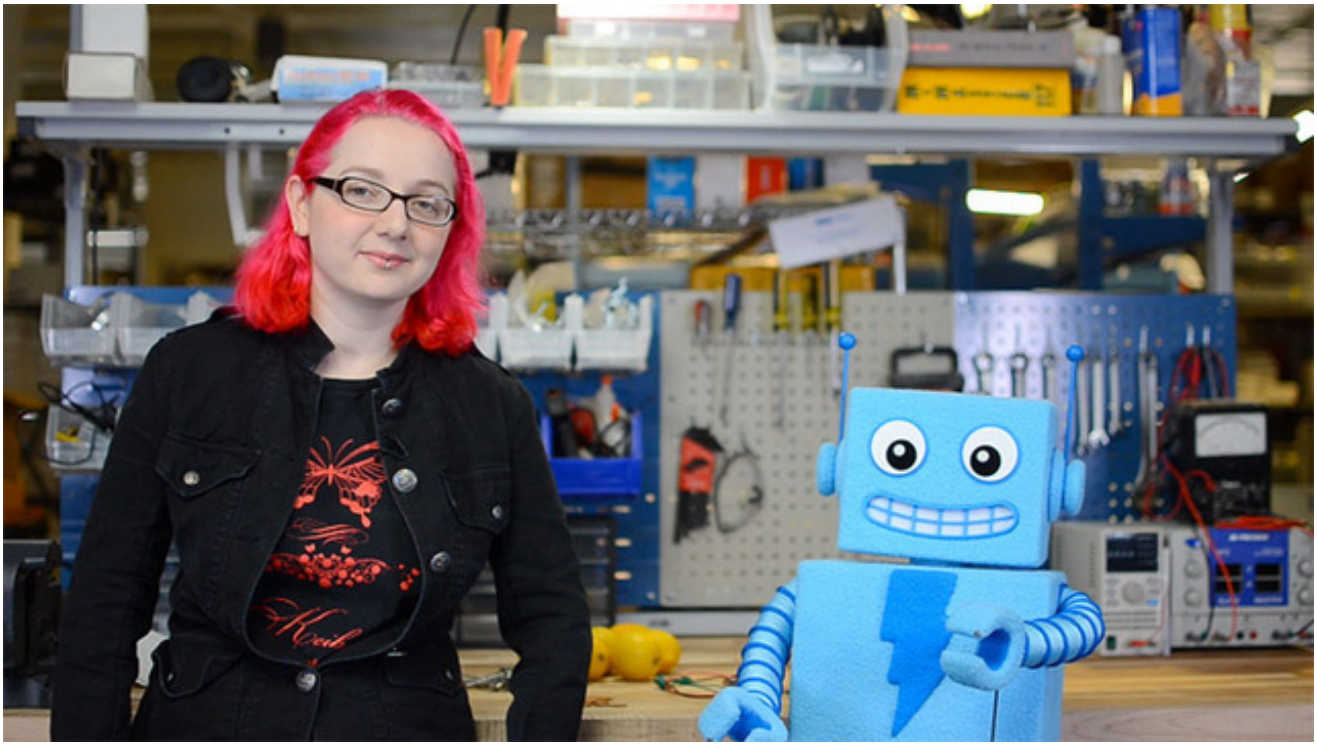


Adabot: And they travel through all those different parts of the circuit to get there?

Ladyada: Yes - and they make lots of things happen along the way.

Adabot: Oh - you mean, like lighting up an LED. or making a motor move!

Ladyada: Exactly - and it all starts inside the battery.



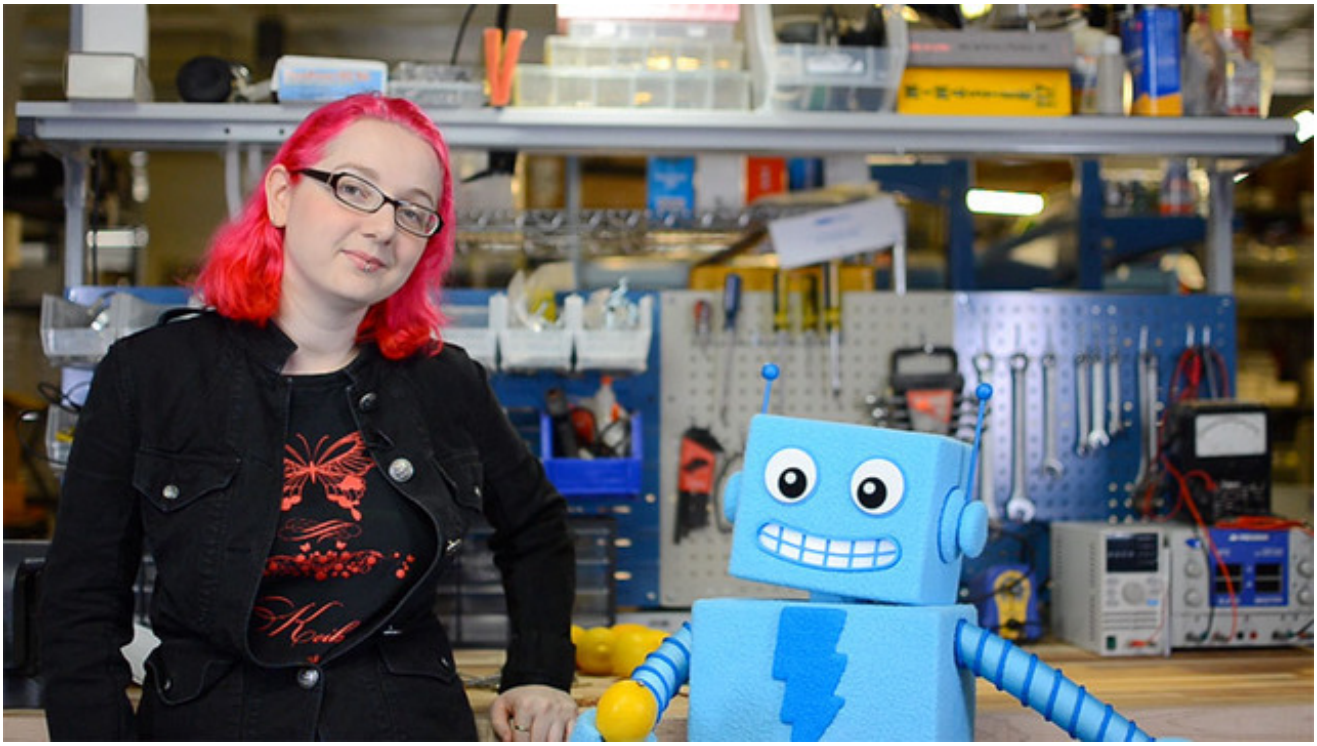
Adabot: I was right - batteries are powerful! They must be very difficult to make.

Ladyada: Actually - we can make our own battery right now. It's easy.

Adabot: Awesome! I'll go get my chemistry set!

Ladyada: Wait -you don't have to - we've got everything we need right here.

Adabot: A Lemon?

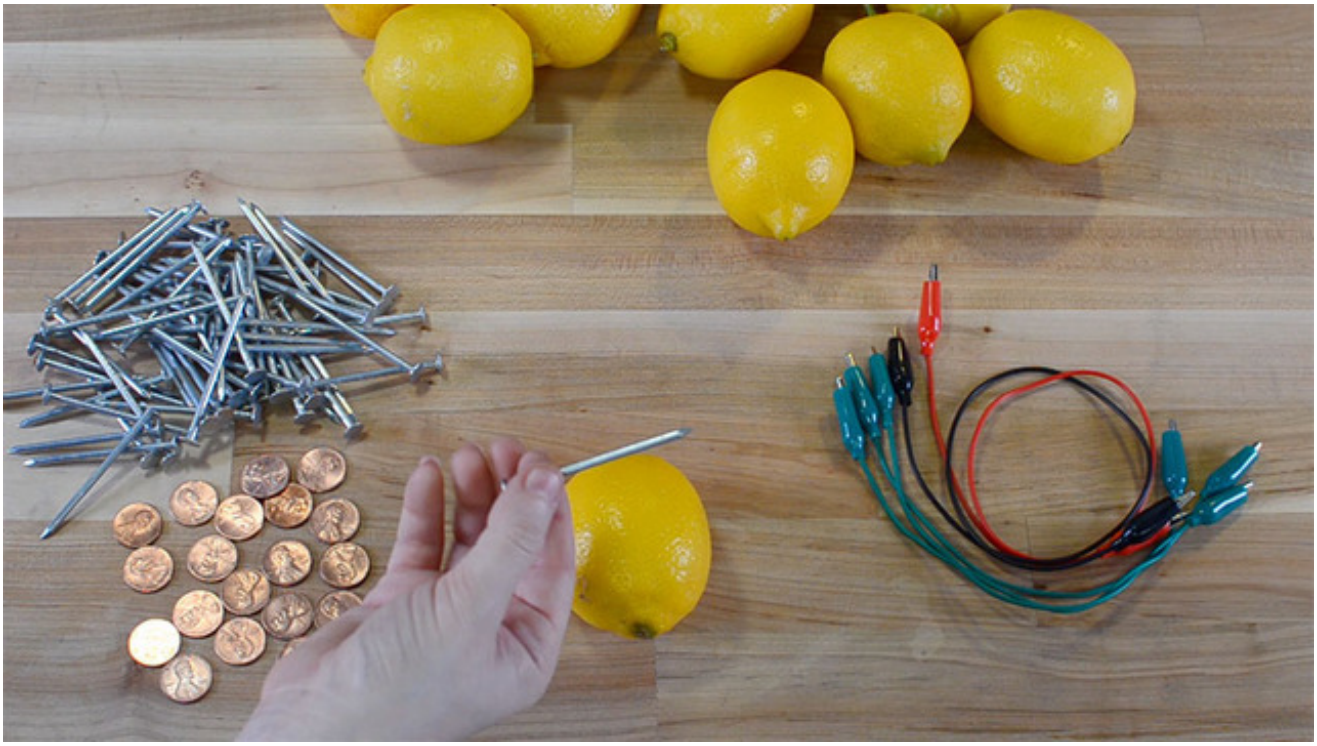


Ladyada: That's right - the juice inside of a lemon can be used as an electrolyte. This galvanized nail is coated with zinc and we can use that as our negative terminal. And this shiny copper penny will make a good positive terminal

Adabot: How do we put it all together?

Ladyada: First we roll the lemon while pressing down on it to make sure there's a lot of juice flowing freely inside.

Ladyada: Then insert the penny and nail. And we're done.



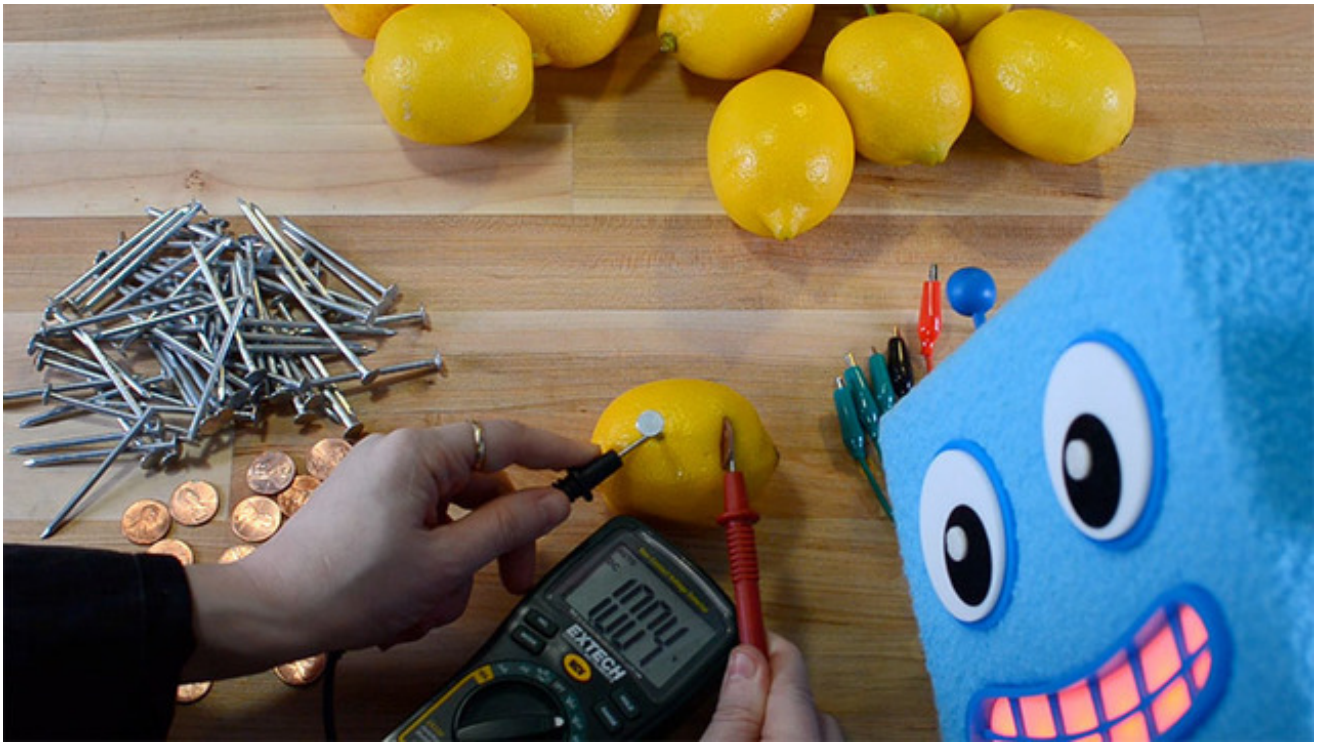
Adabot: You were right - that *was* easy! Can we test it out with a multimeter?

Ladyada: Yup - good idea

Adabot: Our lemon battery is producing about 1 volt. Cool! Is that enough power to light up an LED?

Ladyada: Hmm - not quite. But we *can* link multiple batteries together to increase the voltage.

Adabot: Excellent.



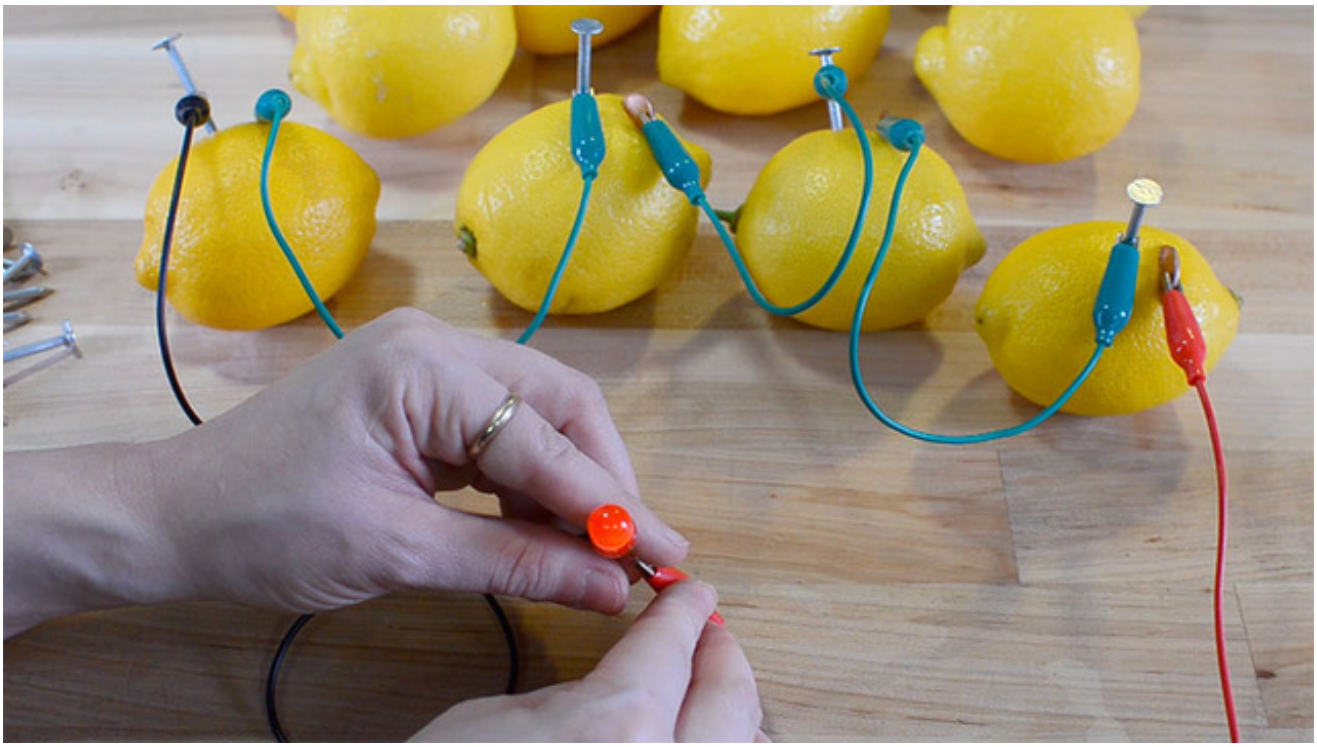
Adabot: Now we have four lemon batteries.

Adabot: But how do we link them together?

Ladyada: To connect batteries in *series* we connect the positive terminal on one battery to the negative terminal of the one next to it.

Adabot: Now the two terminals that are left unconnected are the ones we connect our LED?

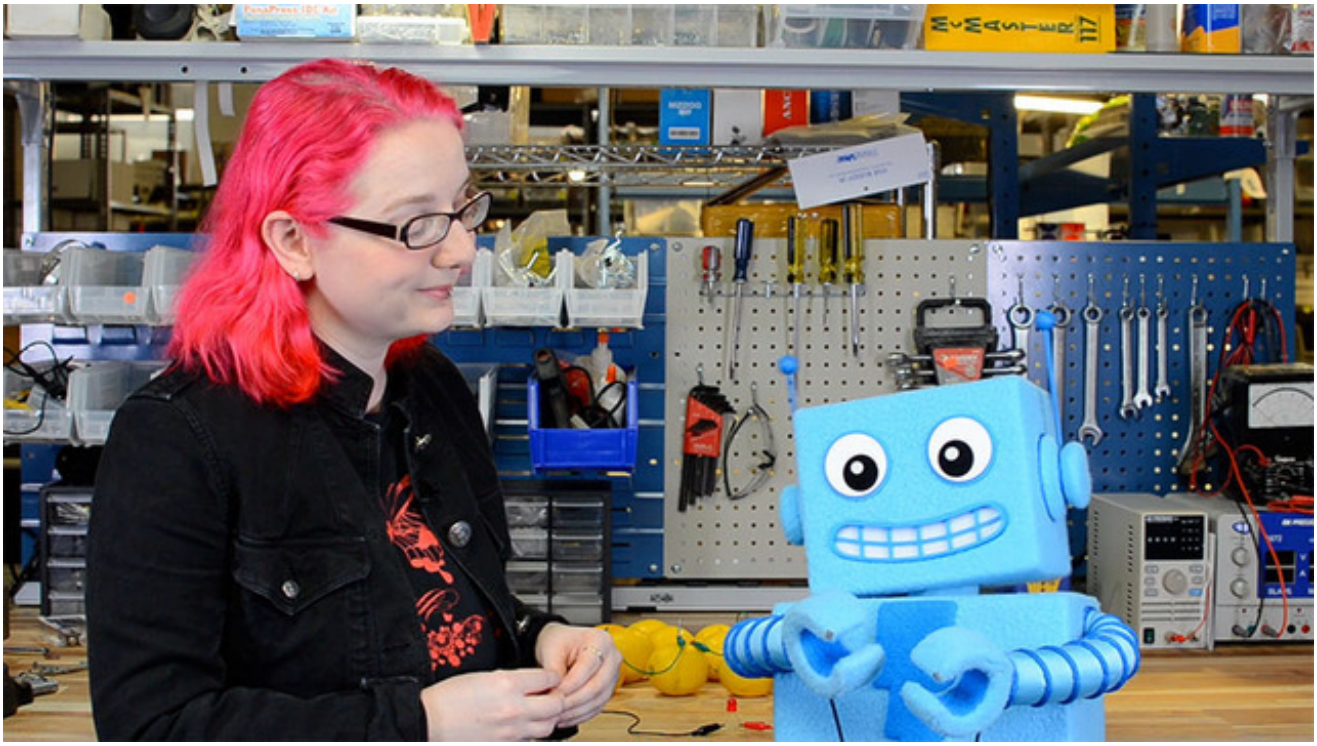
Ladyada: Correct!



Adabot: It works! An LED powered by lemons!

Ladyada: Not just lemons - don't forget - it's the lemon, nail and penny that are working together to create electrical current.

Adabot: Right - they make a great team!



Adabot: This great - with all these lemons, we'll never have to buy batteries again!

Ladyada: Well - I don't think we could fit a lemon inside my multimeter. We're still better off using regular batteries.

Adabot: Oh ...

Adabot: Can we make lemonade instead?

Ladyada: Umm ... sure, why not?

What is a battery?

from Wikipedia (http://adafru.it/dqC)

photo by Lead holder (http://adafru.it/dqH)

An electric **battery** is a device consisting of one or more electrochemical cells (http://adafru.it/dqI) that convert stored chemical energy into electrical energy. Each cell contains a positive terminal, or cathode (http://adafru.it/dqJ), and a negative terminal, or anode (http://adafru.it/dqK). Electrolytes (http://adafru.it/dqL) allow ions to move between the electrodes and terminals, which allows current to flow out of the battery to perform work.

Primary (http://adafru.it/dqM) (single-use or "disposable") batteries are used once and discarded; the electrode materials are irreversibly changed during discharge. Common examples are the alkaline battery used for flashlights (http://adafru.it/dqN) and a multitude of portable devices. Secondary (http://adafru.it/dqO) (rechargeable batteries (http://adafru.it/dqP)) can be discharged and recharged multiple times; the original composition of the electrodes can be restored by reverse current. Examples include the lead-acid batteries used in vehicles and lithium ion batteries used for portable electronics. Batteries come in many shapes and sizes, from miniature cells used to power hearing aids (http://adafru.it/dqQ) and wristwatches to battery banks the size of rooms that provide

standby power for telephone exchanges (http://adafru.it/dqR) and computer data centers (http://adafru.it/dqS).

According to a 2005 estimate, the worldwide battery industry generates US$48 billion (http://adafru.it/dqT) in sales each year, with 6% annual growth.

Batteries have much lower specific energy (http://adafru.it/dqU) (energy per unit mass) than common fuels (http://adafru.it/dqV) such as gasoline. This is somewhat mitigated by the fact that batteries deliver their energy as electricity (which can be converted efficiently to mechanical work), whereas using fuels in engines entails a low efficiency of conversion to work.

History

The usage of "battery" to describe a group electrical devices dates to Benjamin Franklin (http://adafru.it/dqA), who in 1748 described multiple Leyden jars (http://adafru.it/dqx) by analogy to a battery of cannon (http://adafru.it/dqB) (Benjamin Franklin borrowed the term "battery" from the military, which refers to weapons functioning together). Alessandro Volta (http://adafru.it/cdO) described the first electrochemical battery, the voltaic pile (http://adafru.it/dqW) in 1800. This was a stack of copper and zinc plates, separated by brine soaked paper disks, that could produce a steady current for a considerable length of time. Volta did not appreciate that the voltage was due to chemical

reactions. He thought that his cells were an inexhaustible source of energy, and that the associated corrosion effects at the electrodes were a mere nuisance, rather than an unavoidable consequence of their operation, as Michael Faraday (http://adafru.it/dqX) showed in 1834.

Although early batteries were of great value for experimental purposes, in practice their voltages fluctuated and they could not provide a large current for a sustained period. The Daniell cell (http://adafru.it/dqY), invented in 1836 by British chemist John Frederic Daniell (http://adafru.it/dqZ), was the first practical source of electricity, becoming an industry standard and seeing widespread adoption as a power source forelectrical telegraph (http://adafru.it/dr0) networks. It consisted of a copper pot filled with a copper sulfate (http://adafru.it/dr1) solution, in which was immersed an unglazed earthenware (http://adafru.it/dr2) container filled with sulfuric acid (http://adafru.it/dr3) and a zinc electrode.

These wet cells used liquid electrolytes, which were prone to leakage and spillage if not handled correctly. Many used glass jars to hold their components, which made them fragile. These characteristics made wet cells unsuitable for portable appliances. Near the end of the nineteenth century, the invention of dry cell batteries (http://adafru.it/dr4), which replaced the liquid electrolyte with a paste, made portable electrical devices practical.

Credits

- **Ladyada:** Limor Fried
- **ADABOT:** Collin Cunningham & Phil Torrone, Puppet by Anney Fresh, design by Bruce Yan
- **Music**: Tom White & Collin Cunningham
- **Intro animation:** Bruce Yan
- **Written, filmed, edited, directed and produced by:** Collin Cunningham, Limor Fried, Phil Torrone and the Adafruit team