Fruit Batteries

Did you know that your fruit bowl is brimming with electrical potential? When life gives you lemons (and a few other household odds and ends), forget about making lemonade – generate home-made electricity instead. *Mwahahaha!*

THE RECORD: Fastest time to light an LED with a fruit battery

THE CHALLENGE: Combine some citrus fruit, copper coins and a few nails to make your very own bio-battery in the fastest possible time.

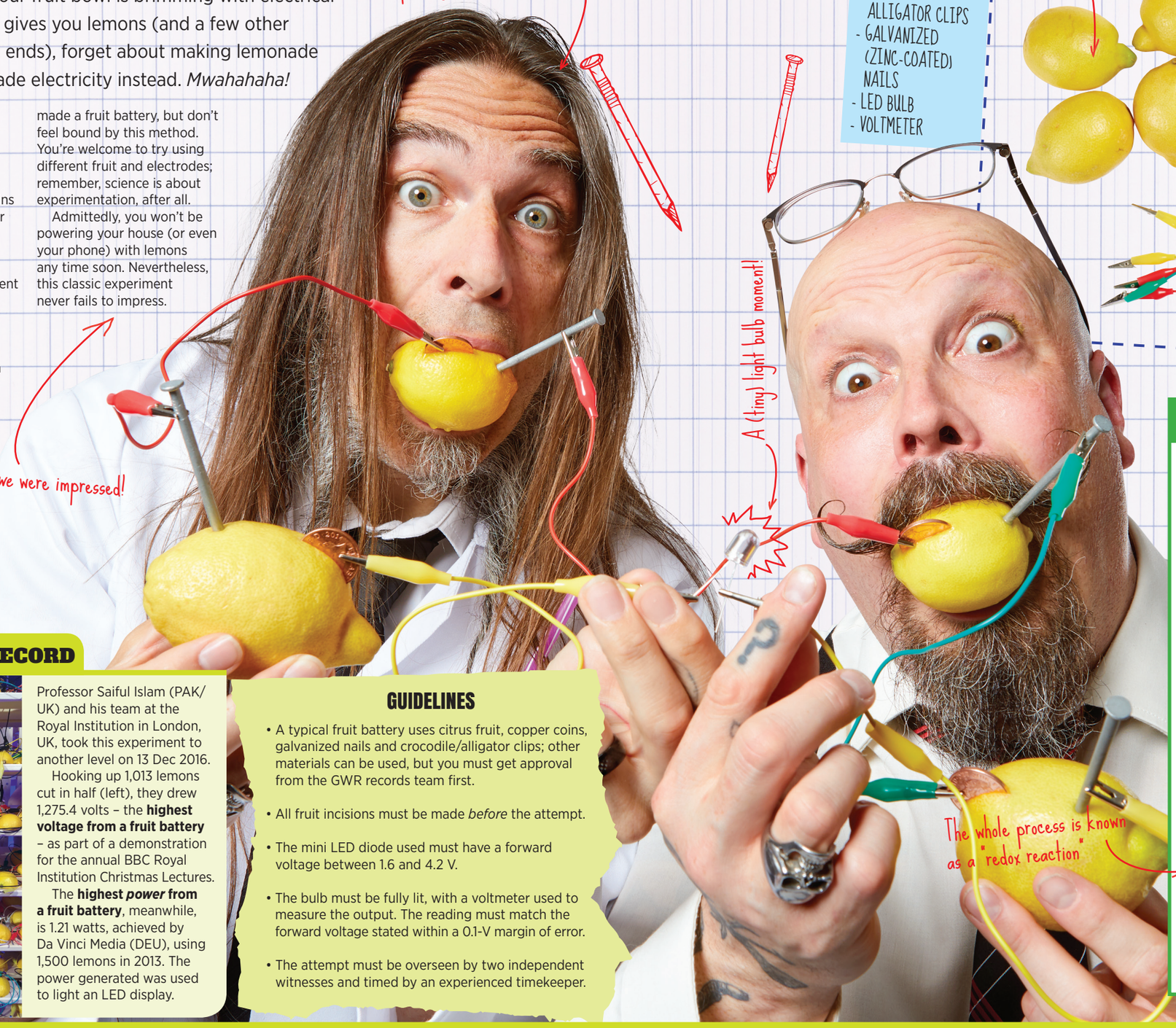
As cool as it is, this experiment isn't just about generating electricity out of seemingly nothing. Speed is also key. You'll need a steady hand and a well-thought-out plan *before* you begin.

Over the page is a step-by-step guide to how we made a fruit battery, but don't feel bound by this method. You're welcome to try using different fruit and electrodes; remember, science is about experimentation, after all.

Admittedly, you won't be powering your house (or even your phone) with lemons any time soon. Nevertheless, this classic experiment never fails to impress.

The levels of electricity are so low that it's safe to touch – you'll just feel a slight tingle. Avoid putting it in your mouth, though!

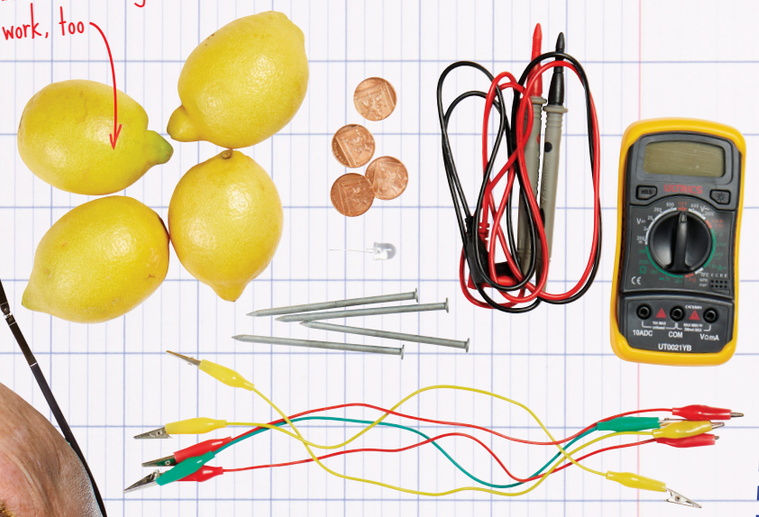
Well, we were impressed!



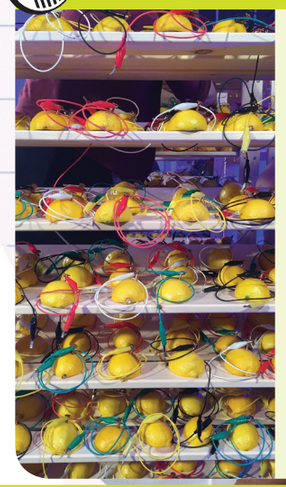
WE USED:
- CITRUS FRUIT
- COPPER COINS
- CROCODILE/ ALLIGATOR CLIPS
- GALVANIZED (ZINC-COATED) NAILS
- LED BULB
- VOLTMETER

SHOPPING LIST

Limes and oranges work, too



FOR THE RECORD



Professor Saiful Islam (PAK/UK) and his team at the Royal Institution in London, UK, took this experiment to another level on 13 Dec 2016.

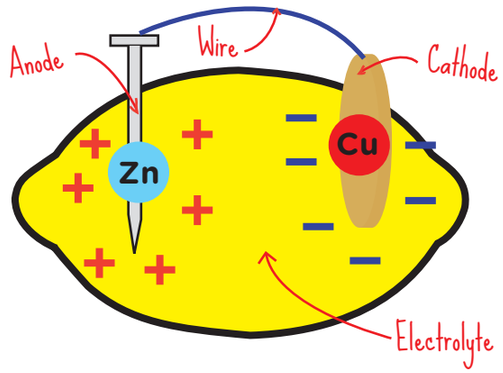
Hooking up 1,013 lemons cut in half (left), they drew 1,275.4 volts – the **highest voltage from a fruit battery** – as part of a demonstration for the annual BBC Royal Institution Christmas Lectures.

The **highest *power* from a fruit battery**, meanwhile, is 1.21 watts, achieved by Da Vinci Media (DEU), using 1,500 lemons in 2013. The power generated was used to light an LED display.

GUIDELINES

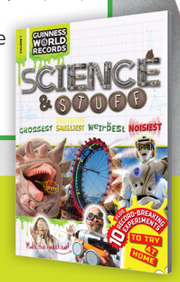
- A typical fruit battery uses citrus fruit, copper coins, galvanized nails and crocodile/alligator clips; other materials can be used, but you must get approval from the GWR records team first.
- All fruit incisions must be made *before* the attempt.
- The mini LED diode used must have a forward voltage between 1.6 and 4.2 V.
- The bulb must be fully lit, with a voltmeter used to measure the output. The reading must match the forward voltage stated within a 0.1-V margin of error.
- The attempt must be overseen by two independent witnesses and timed by an experienced timekeeper.

HOW DOES IT WORK?



All batteries (including bio-batteries, like this) consist of three key parts: a positive electrode (cathode) that is looking to shed electrons, a negative electrode (anode) that is looking to pick up electrons, and some form of fluid/solution (electrolyte) connecting the two. Once the electrodes are linked up (usually by a wire), the electrons begin to flow and hey presto, you have electricity.

Reacting to the citric acid in the lemon, the zinc (nail) is "oxidized" (i.e., it loses electrons), whereas the copper (coin) is "reduced" (i.e., it gains electrons). The lemon juice serves the role of "electrolyte" – a conductive pathway through which positive ions can flow. Electrons then travel through the external crocodile clips to complete the circuit.



Fruit Batteries (continued)

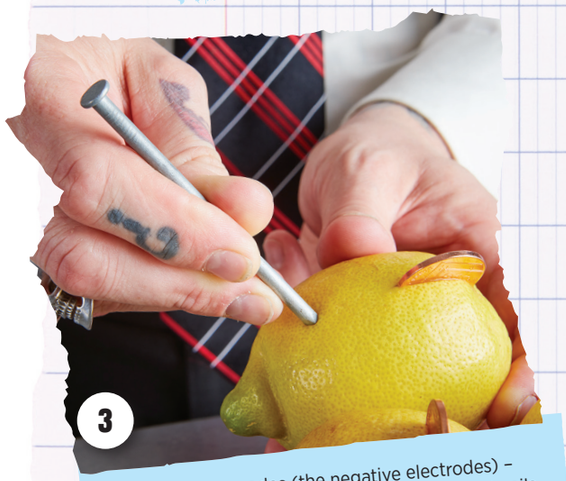
1

First, give your lemons a quick roll to make sure the insides are extra juicy. Carefully use a knife or scissors to pre-cut two slots/holes in one side of each lemon – this must be done *before* attempting the **fastest time to light an LED with a fruit battery**.

2

Give your coins a clean to remove any built-up grime

Once the timer starts, the first thing you'll need to do is insert all of your electrodes into the pre-made holes. We've begun with the cathodes (the positive electrodes): the copper coins.



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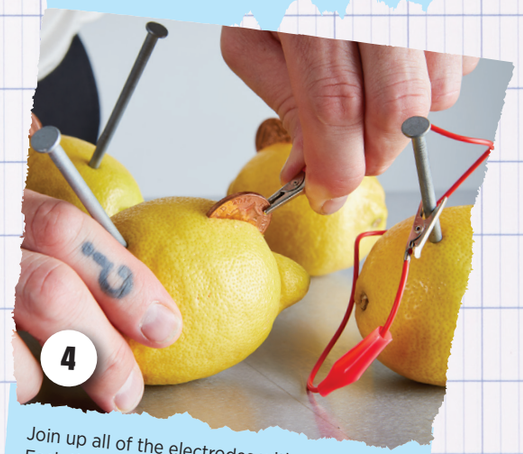
Next, add your anodes (the negative electrodes) – we're using galvanized nails. Both the coins and nails need to go in deep enough to be in contact with the pulpy centre, but leave enough metal exposed to easily attach the clips.



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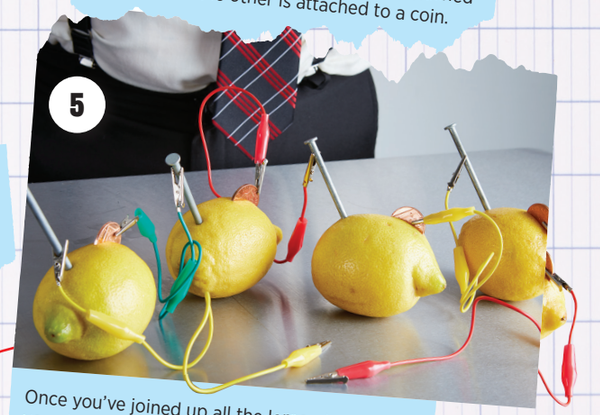
Join up all of the electrodes with crocodile clips. Each time, make sure that one end is attached to a nail and the other is attached to a coin.



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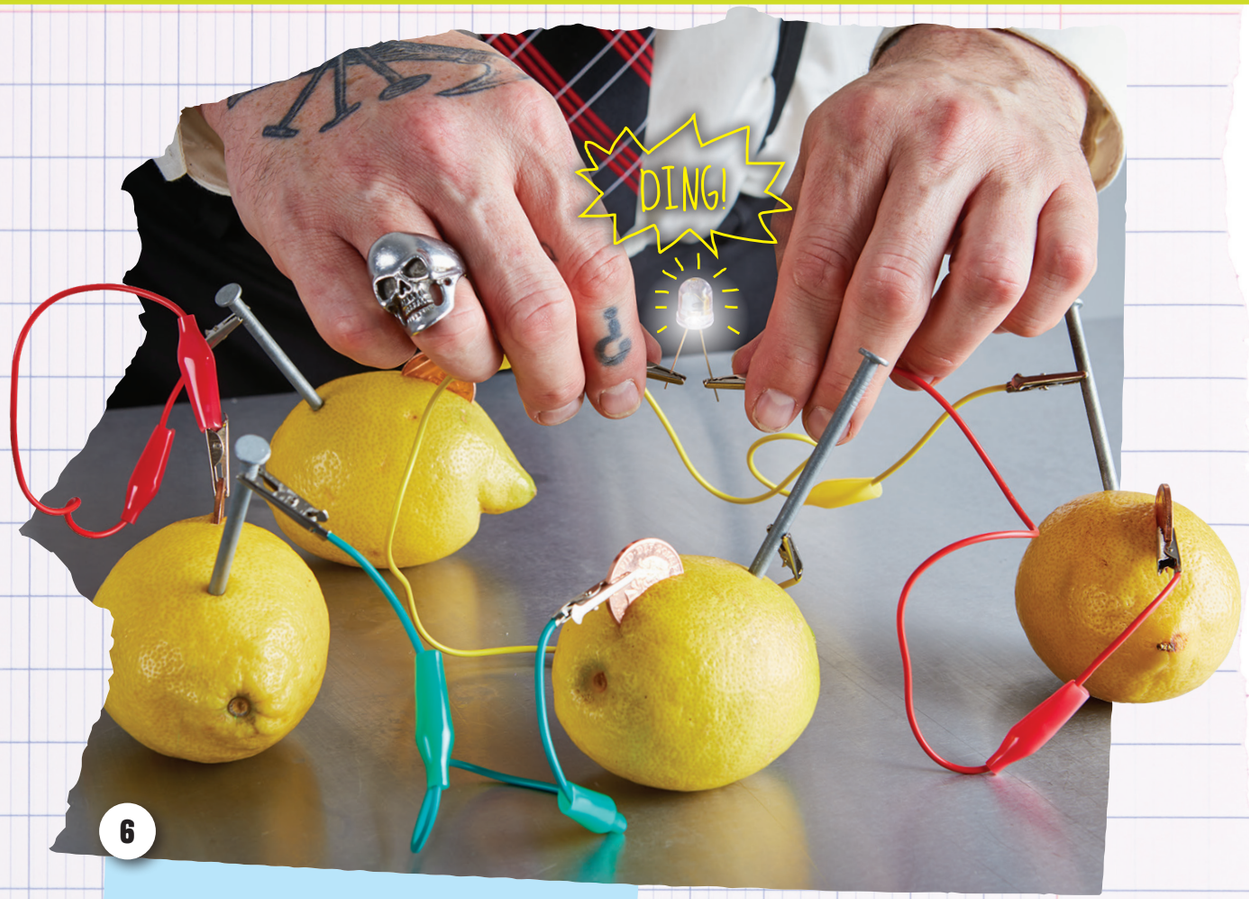
In a "batteries in series" configuration, each cell (or lemon in this case) contributes to the total voltage

Once you've joined up all the lemon batteries, you should be left with two free clips at the ends – one coming from a nail and the other from a coin. These will hold the LED.



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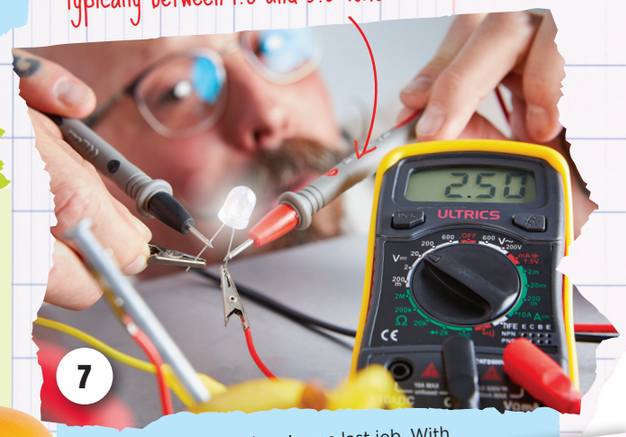
To complete the circuit, attach the clips to the diode. The lead from the coin should go to the negative "leg" (often indicated by a flattened edge on the plastic casing). As soon as the LED is fully lit, the timer can be stopped.

The forward voltage of an LED is typically between 1.8 and 3.3 volts



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Before you pack up, there's one last job. With the voltmeter, take a reading of the output and photograph the display to send as evidence. It must be within 0.1 volts of the LED's stated forward voltage to be valid.

TOP TIP!

FROM PROFESSOR ORBAX

The components we have used here are just one way of making a fruit battery. Why not try experimenting with other types of fruit? Acid is essential to the process, so it's best to stick with citrus fruit, such as limes, grapefruit and oranges. It won't qualify for this particular record, but you can also create a battery out of potatoes (this relies on phosphoric, rather than citric, acid). It's possible to use alternative copper/zinc objects for the electrodes, too – or even different metals altogether. Just make sure that you run your equipment list past the records team at **www.guinnessworldrecords.com** first.