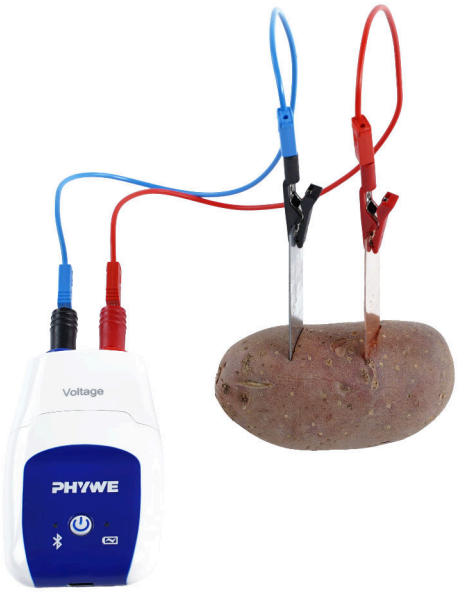
A remarkable source of electric current with Cobra SMARTsense



Pupils gain an insight into the field of electrochemistry and learn the basics of how a battery is constructed.

Chemistry > Physical chemistry > Electrochemistry > Electrochemical measurement set

Difficulty level	Group size	Preparation time	Execution time
easy	2	10 minutes	10 minutes

This content can also be found online at:

https://www.curriculab.de/c/68a85e85a65c99000273a904

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Teacher information

Application

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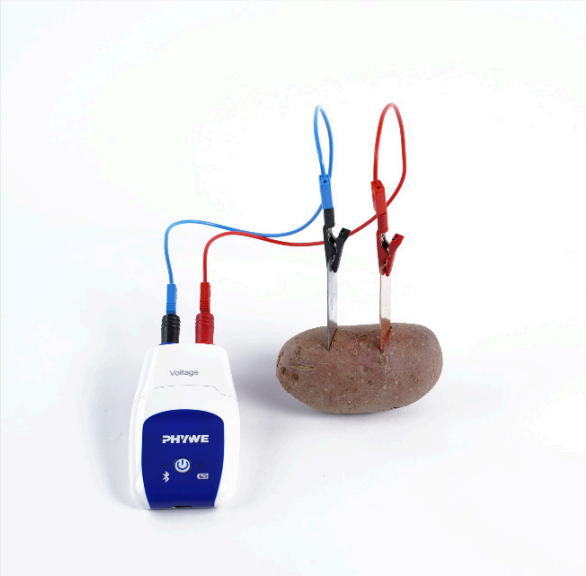

The discovery and further development of galvanic elements, i.e. batteries, was a significant step forward for mankind. They enable the mobile power supply of many devices and have had a major impact on our modern everyday lives.

Batteries all work according to the same principle: the difference in the standard potentials of the materials used determines the voltage that a battery can supply.

In this experiment, such an electrical voltage is to be generated with the aid of a **Potato battery** are generated.

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Other teacher information (1/3)

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Prior knowledge

The students should already know how a galvanic cell works and how it is constructed. They should also have a basic knowledge of voltage, in particular the associated unit (volt) and the methods for measuring voltage.

Principle

Two different metal electrodes - in this case made of zinc and copper - are inserted into a potato. Under optimal conditions, a voltage of approx. $1,1\ \mathrm{V}$ measure. This results from the difference between the redox potentials of copper and zinc. As the conditions in the potato cannot be precisely controlled, the voltage actually measured may be slightly lower.

Other teacher information (2/3)

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Learning objective

The students gain an insight into electrochemistry and learn the basics of the structure of a battery. They understand that the measured voltage results from the difference between the standard potentials of the metals used and can be predicted using the voltage series. The students also understand that a potato contains electrolytes that are essential for the function of a galvanic cell.

Tasks

A galvanic cell is to be constructed using a potato and one zinc and one copper electrode. The voltage generated by this cell is measured and documented using a voltage sensor (Cobra SMARTsense Voltage).

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Safety instructions

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- The general instructions for safe experimentation in science lessons apply to this experiment.
- To sensitise pupils to working safely in the laboratory, they can also wear safety goggles here.

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Student information

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Motivation

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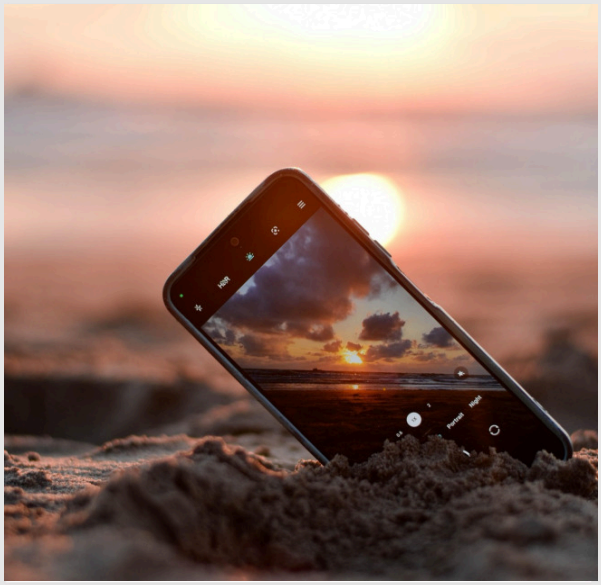

Without batteries, our everyday lives would be almost inconceivable, whether in a smartphone, a watch or a simple torch. But how exactly is the electrical energy in a battery generated?

For electricity to flow, two different materials need to react with each other and exchange electrons in the process. This principle is based on the difference between the standard electrical potentials of different materials. The level of voltage generated therefore depends on which metals are used.

In this experiment, a so-called "potato battery" is built using simple means (a potato and two metal electrodes) to generate an electrical voltage.

Tasks

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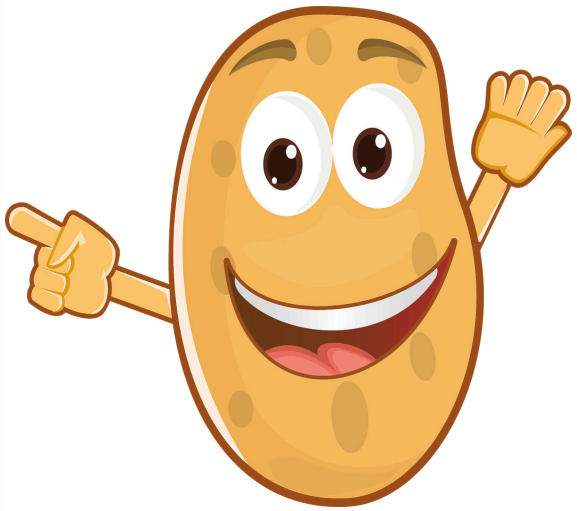

Can a battery be made from a potato?

1. Build a galvanic cell from a potato and one zinc and one copper electrode.
2. Measure the voltage generated.

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Equipment

Position	Material	Item No.	Quantity
1	Cobra SMARTsense Voltage - Sensor for measuring electrical voltage ± 30 V (Bluetooth + USB)	12901-02	1
2	Connecting cord, 2 mm-plug, 5A, 500 mm, red	07356-01	1
3	Connecting cord, 2 mm-plug, 5A, 500 mm, blue	07356-04	1
4	Reducing plug 4mm/2mm socket, 2	11620-27	1
5	Alligator clip, insulated, 2 mm socket, 2 pcs.	07275-00	1
6	Copper strip electrode for student electrochemistry experiments Length: 75 mm, width 15 mm	07856-10	1
7	Emery paper, medium	01605-00	1
8	Zinc strip electrode for student electrochemistry experiments Length: 75 mm, width 15 mm	07856-20	1

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Structure (1/2)

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For measurement with the **Cobra SMARTsense sensors** the **PHYWE measureAPP** required. The app can be downloaded free of charge from the relevant app store (see below for QR codes). Before starting the app, please check whether your device (smartphone, tablet, desktop PC) is running **Bluetooth activated** is.

iOS

Android

Windows

Structure (2/2)

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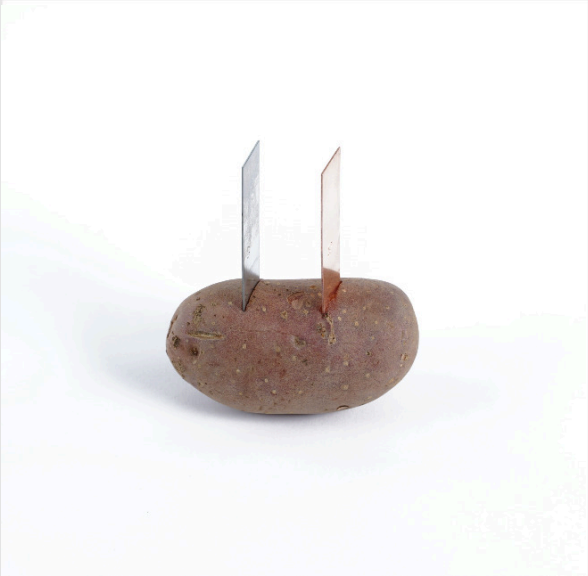
First look at the metal electrodes (copper and zinc sheet). If the copper has oxidised due to storage, use a piece of sandpaper to clean it.

Insert the electrodes into the potato a few centimetres apart to about the same depth.



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Procedure (1/2)

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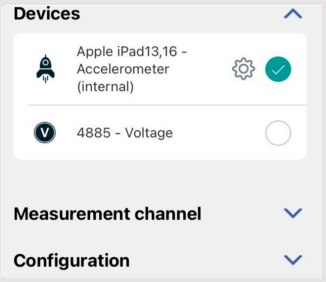
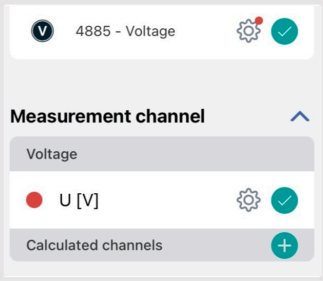
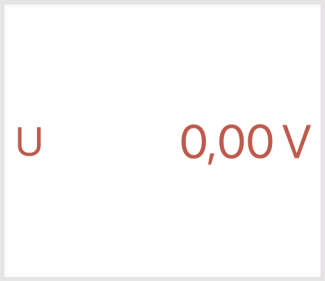
- Start the measureAPP on a mobile device.
- Press the start button on the sensor for approx. 3 seconds.
- Connect the sensor by tapping ◯ next to the description of the sensor in the measureAPP.
- Set the measured value display by tapping 0.0 above the diagram.







Procedure (2/2)

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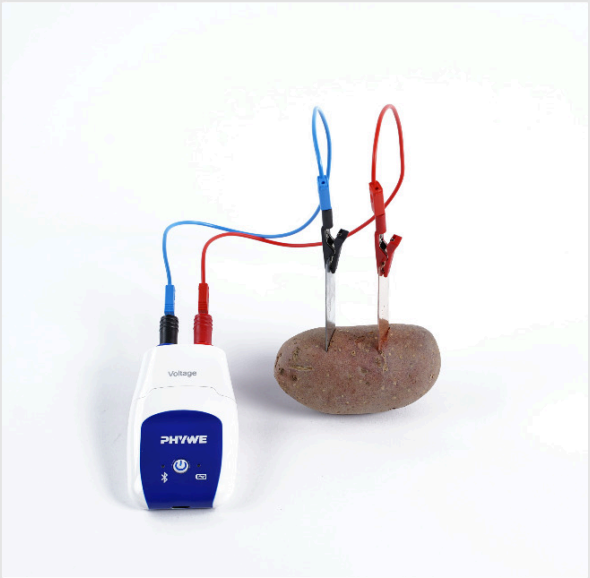
Note the colour of the connections below: blue (zinc, negative pole) always to blue (black) and red (copper, positive pole) always to red!

Connect the crocodile clips to the metal electrodes (copper and zinc sheet) and the leads to the Cobra SMARTsense Voltage Sensor using a reducing plug.

Make a note of the voltage displayed.



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Report

Task 1

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Various voltages are given below. Which of these is closest to the voltage you have noted?

- ○ $3,33\,\mathrm{V}$
- ○ $4,44\,\mathrm{V}$
- ○ $2,22\,\mathrm{V}$
- ○ $1,11\,\mathrm{V}$

Check

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Task 2

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The cell voltage for a $\mathrm{Zn}|\mathrm{Zn}^{2+}||\mathrm{Cu}^{2+}|\mathrm{Cu}$ cell is $1,11\ \mathrm{V}$. How can any deviations from the literature value be explained in the experiment?

- [ ] Standard conditions are exactly maintained in the potato, so the measured value should correspond to the literature value.
- [ ] The acid contained in the potato acts as an electrolyte, but its composition can vary and thus influence the voltage.
- [ ] The metals used may contain impurities that change the electrochemical behaviour.

Check

Task 3

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What would happen if you tried to operate such a battery with two identical electrodes (e.g. copper)? What voltage would be measured and why?

- ○ No voltage could be measured. The principle of the potato battery is based on the fact that the less noble of the two inserted electrodes dissolves, creating positive ions. The more noble metal becomes positive as electrons are removed from it. This results in a different charge, which can be measured.
- ○ The measurable voltage would be much higher, as both metals introduced are exactly the same. The electrons can therefore switch back and forth between the electrodes much better, resulting in a higher voltage.

Check

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Slide	Score / Total
Slide 15: Potato tension	0/1
Slide 16: Standard potential	0/2
Slide 17: Two identical electrodes	0/1

Total amount 0 / 4

Solutions Repeat

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