YEAR 6

Potato Power

40 mins

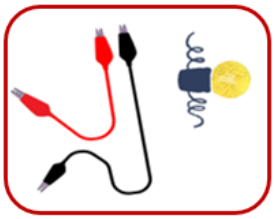
MATERIALS

- 1 potato per group.
- 1 LED.
- 1 zinc plated nail (galvanized nail).
- 1 piece of copper sheet/ a copper nail.
- Copper wire/ alligator clamps.

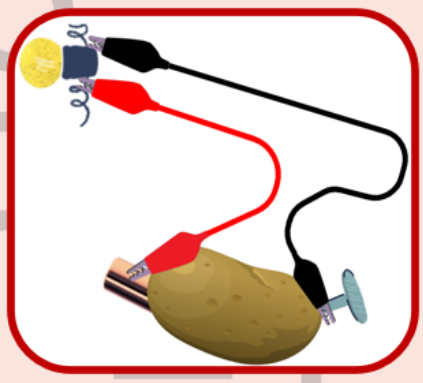
METHOD:

1. Push the nail into one end of the potato & push the copper metal into the opposite end of the potato.

2. Attach the end of the Red alligator clamp to the copper (+) and the **Black** alligator clamp to the zinc nail (-).



3. Connect the Red alligator clamp to the long arm of the LED & **Black** alligator clamp to the short arm.



4. Observe your LED, if more power is required try making a bigger circuit by adding more potatoes.

WHY?

Potatoes contain vitamins, minerals, water, carbohydrate, protein & fibre. It is the presence of the water, sugars and acid within the potato that allows electrons to flow between the metals to form an electrical current. The copper & zinc react effectively forming electrodes, the zinc acts as the electron rich anode (- neg) whilst the electron poor copper acts as the cathode(+ positive).

Potato Power Experiment

Lesson Outline:

Time allocation: **40 mins**

Format: Independent/ group work.

Student outcomes:

- Create an electrical circuit which will power a light Emitting Diode (LED) using a potato.
- Understand that an electrical current involves the transfer of electrons between an anode and a cathode via an electrolyte, the movement of which generates the electrical charge.
- Utilise science inquiry skills.
- Enhance literacy and critical evaluation skills.
- Enhance food literacy and food experience skills.

Materials:

FOR EACH GROUP

- Raw potatoes
- 1 LED
- Alligator clips/ copper wires
- Galvanized nails
- Copper (pipe/metal sheet/ coins)

Optional/ Extra Material: Printed copies of the linked article on potato power research.
https://www.bbc.com/future/article/20131112-potato-power-to-light-the-world

Variation:
Cold potatoes which have been previously boiled for 8 minutes and a multimeter may also be included for each group to test if it improves electrical conductivity as suggested by the article. Or you may like to divide the class into groups that have different fruits and vegetables like potatoes, tomatoes, lemons, or cucumbers to comparatively investigate their conductivity potential.

Preparation:

Print or display experiment set up poster for the groups to follow and print student worksheets if required.

Setup: 2 mins

Assemble all necessary equipment for the children to access when conducting their experiment/s.

Introduction: 3 mins

Ask: Can fruits and vegetables generate power?

In todays experiment we are going to explore if they can, you are going to have a go at constructing an electrical circuit using potatoes to investigate if they can generate enough power to light up a small light bulb/ LED.

Investigation: 20 mins

Working in small groups of 2 or 3 ask the students to follow the instructional poster to conduct their experiment and fill out their worksheet.

N.B You may have chosen to comparatively investigate raw vs cooked potatoes or give the groups an assortment of fruits or vegetables to test.

Discussion: 10 mins

Ask: How did you go? Did you get power?

Ask: Does anyone know how/ why the potato battery works?

To begin with we need to understand that the potato itself is made of carbohydrates, protein, water, vitamins, and minerals. Which means it is made of/contains chemicals that can theoretically undergo chemical reactions when exposed to other chemicals or reactive molecules.

Zinc and the copper are known as reactive metals that can also undergo chemical reactions also.

So when we put them all together chemical reactions do occur. Firstly the zinc on the nail reacts with the acids in the juicy potato flesh. Phosphoric acid is the acid in the potato and when the zinc chemically reacts with it, electrons are released by the zinc into the potato and these electrons travel through the potato and the copper wires to the copper.

The copper is an electron loving metal and the electrons are attracted to it thus freely moving through the potato toward it. Therefore we have chemical energy from chemical reactions moving through an electrolyte (the phosphoric acid) being converted into electrical energy.

It is this movement of electrons between the zinc and the copper that generates the electrical charge. Our metals zinc and copper are referred to as the electrodes, with the electron giving zinc called the anode and the electron loving copper called the cathode just like in a battery you would buy to power things at home. The potato battery and the batteries you buy at the shops are both types of electrochemical cells.

Ask: What other fruits, vegetables or liquids do you think you could try experimenting with instead of a potato? Why?

N.B You may choose to distribute the attached article for students to read at this time to continue further discussion about the viability and sustainability of the potato battery/ potato power.

Conclusion: 5 mins

Ask the students to pack away their experiments.

Take away messages:

Chemical reactions can create changes we can see and are involved in many familiar processes.

- As a result of the chemical reactions occurring in the potato power is generated to power/ light up the LED.

Chemical energy can be converted into electrical energy, this is known as electrochemistry.

- It is the free movement of electrons between the anode and cathode via the electrolyte that generates the electrical charge/ electricity.

Foods are comprised of vitamins, minerals and molecular compounds which means they too can undergo chemical reactions.

- Potatoes are comprised of carbohydrate (starch), protein, water, vitamins, and minerals.
- The zinc chemically reacts with the phosphoric acid in the potato to produce electrical energy. The potato is the electrolyte source for the electron transfer.

Further Topic Inquiry

This experiment can be further explored within the context of the Health and Physical Education Curriculum. Providing an opportunity for students to develop strategies to ensure safety and wellbeing at home and at school, such as identifying and choosing healthier foods and drinks for themselves.

Refresh.ED provides unit resources for specific year groups within their Food & Drink Choice and Food, Drink & Health focus areas. Of particular interest in relation to extending learning within this area is the unit.

- Year 5 Food Systems.
- Year 6 A Closer Look at Nutrients and Energy.

Potato Power

1. Draw a picture of your potato battery set up below. Label your equipment; potato, anode (-), cathode (+), wires/clips and LED. Draw in arrows to depict the flow of electrons in your circuit.

2. How does the potato help the circuit work?

Overview

In this experiment students explore the creation of an electrical circuit, potential conductivity of a food source, and electricity. Potatoes provide the basis of the experiment where students use them to create an electrical circuit to power a Light Emitting Diode (LED). A linked article on potato research is also included in this module to facilitate discussion around future power sources and sustainability.

Some key new vocabulary students will be introduced to includes: Electrical circuit, electrochemistry, anode, cathode, electron, LED, electrolyte, sustainability.

Key Messages

- The potato performs as an electrochemical battery cell in this experiment, converting chemical energy into electrical energy to power the LED.
- Electrical charge is first generated by the chemical reaction of the zinc with the phosphoric acid (electrolyte) in the potato followed by the transfer of electrons between the anode and the cathode. This is known as Electrochemistry.
- The potato contains phosphoric acid which performs as the electrolyte in the potato battery experiment. Various fruits and vegetables can provide a source of electrolyte/ acid for electrical conductivity.
- More potatoes can be added to form a larger circuit to produce a greater power output.

Learning Outcomes:

- Create an electrical circuit which will power a LED using a potato.
- Understand that an electrical current involves the transfer of electrons between an anode and a cathode via an electrolyte, the movement of which generates the electrical charge.
- Utilise science inquiry skills.
- Enhance literacy and critical evaluation skills.
- Enhance food literacy and food experience skills.

General capabilities:

Literacy, Critical & creative thinking, Personal & social capability, Ethical understanding.

Year 6 Australian Curriculum Links

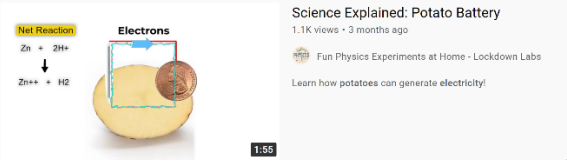
Strand/ Sub- strand	Curriculum content descriptions
SCIENCE	
Science understanding. *Chemical sciences.*	Changes to materials can be reversible or irreversible. Describing what happens when materials are mixed (ACSSU095).
Physical sciences.	Electrical energy can be transferred and transformed in electrical circuits and can be generated from a range of sources. Recognising the need for a complete circuit to allow the flow of electricity. Investigating different electrical conductors and insulators. Considering whether an energy source is sustainable (ACSSU097).
Science as human endeavour. *Use & influence of science.*	Scientific knowledge is used to solve problems and inform personal and community decisions. Considering how personal and community choices influence our use of sustainable sources of energy. Discussing the use of electricity and the conservation of sources of energy. Investigating how electrical energy is generated in Australia and around the world (ASCHE100).
Science inquiry skills. *Questioning & predicting.*	With guidance, pose clarifying questions and make predictions about scientific investigations (ACSIS232).
Processing & analysing data & information.	Compare data with predictions and use as evidence in developing explanations. Sharing ideas as to whether observations match predictions and discussing possible reasons for predictions being incorrect (ACSIS221).
Communicating.	Communicate ideas, explanations and processes using scientific representations in a variety of ways, including multi-modal texts (ACSIS110).
ENGLISH	
Literacy. *Interacting with others.*	Participate in and contribute to discussion, clarifying and interrogating ideas, developing, and supporting arguments, sharing, and evaluating information, experiences, and opinions (ACELY1709). Participating in pair, group, school, and community speaking and listening situations, including informal conversations, discussions, debates, and presentations (ACELY1816).
TECHNOLOGY	
Design Technologies. *Design & technologies knowledge & understanding.*	Examine how people in design and technologies occupations address competing considerations, including sustainability in the design of products, services, and environments for current and future use (ACTDEK019). Investigate characteristics and properties of a range of materials, systems, components, tools, and equipment and evaluate the impact of their use (ACTDEK023).

External Supporting Resources for Teachers

- Potato power research & sustainability article.

https://www.bbc.com/future/article/20131112-potato-power-to-light-the-world

- Video explanation of how the potato battery works.



https://www.youtube.com/watch?v=i9obs2OwC0U

- Questacon video guide to creating a multi- potato circuit (no dialogue).

https://www.youtube.com/watch?v=SOsE5ECH_IM