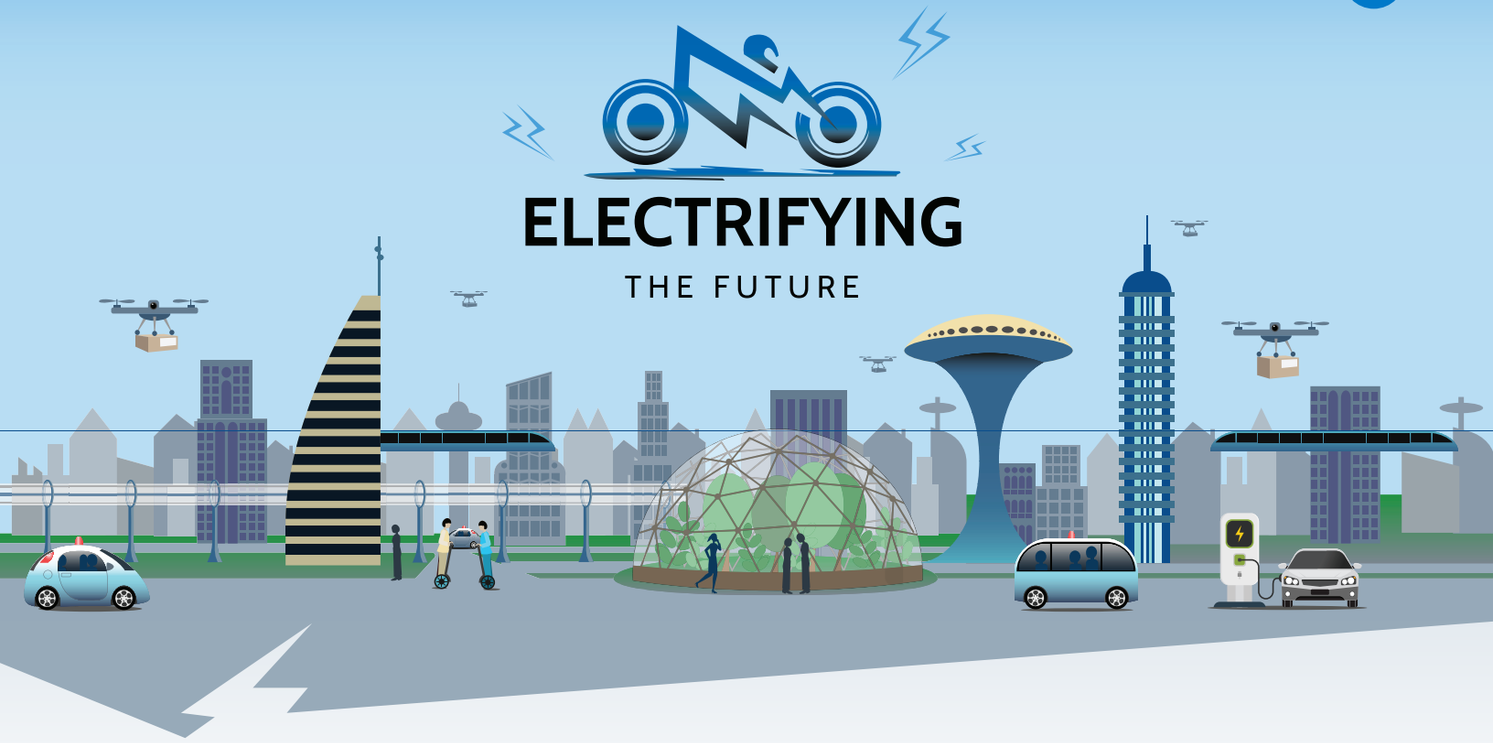
LESSON PLAN 4: THE POWER OF FRUIT

– from the Goodman School of Mines at Laurentian University –



DESCRIPTION

In this interactive lesson, participants will learn how to create a circuit using lemons as a power source. They will explore electricity, batteries and electric vehicles.

MATERIALS

- 1-3 Bells (found in Deluxe Solar Kits) and Mini LED Light Bulbs per group
- 4 pieces of Copper Wire per lemon
- 4 Zinc Screws/Nails per lemon
- 4 Lemons for each group of 3-4 participants (to purchase)
- 5 Alligator clip leads
- Small Trays (optional)

OBJECTIVES

- ☆ Learn that fruit contains electrolytes that can be used as a source of power.
- ☆ Learn that electrons flow through conductive copper wires to transport electricity.
- ☆ Learn about voltage, current, and how such factors impact electrical loads.
- ☆ Learn about the power requirements of electrical devices and how factors such as voltage and current impact how those devices function.
- ☆ Understand how electrical circuits function and impact the flow of electricity.
- ☆ Demonstrate and understand how electricity, power production, and power storage impacts their daily life.

PREPARATION

- Before the beginning of the lesson, set out a tray for each group of participants with four lemons, 4 pieces of copper and zinc for each lemon, and 5 leads (the wires with alligator clips at the end) to connect each of the lemons and the bell or light bulb.
- Set them aside prior to the lesson so that they are ready for the beginning of the lesson.
- Please note: preparing an extra, demonstration lemon battery may be helpful with younger groups to demonstrate how to complete the activity before participants begin.

OUTCOMES: *See end of document for Grades 1-8 outcomes that may apply to this lesson.*

ELECTRIFYING THE FUTURE

SAFETY NOTES

This lesson contains sharp materials that may cause lacerations or an allergic response to participants. Please take the requisite precautions to ensure that participants are safe while conducting the activity.

PRESENTATION & ACTIVITY

This lesson plan is designed to be completed alongside the "Power of Fruit" presentation (Powerpoint or Google Docs versions are available for download at electrifyingthefuture.ca).

Introduction

1. Introducing the experiment- "Today we are going to be learning how to make batteries out of lemons."
2. Work through the included presentation. Consider the following interactive questions while presenting:
   a. "Does anybody know what electricity is?" (Explain that electricity is the flow of energy that gives powerable things the ability to move or light up. The fruit is able to give power due to the current {flow of electrons} caused by the dissolving of metal ions)
   b. "Can anybody tell me what a battery is?" (Explain that a battery is a device that is able to produce electricity with different reactions of chemicals)
   c. "What do you think will happen if the current/ voltage increases?" (Explain that the power would increase and be able to handle bigger loads {things to light up})
   d. "Has anyone ever ridden in an Electric Vehicle? How are they powered?" (Explain that Electric Vehicles use batteries as an alternative to gas. This is how they move and operate.)
3. For younger students - Take the extra 'demonstration' tray to walk through the lemon battery experiment with students, highlighting the important components such as:
   a. Where each of the components have to be placed (i.e. connecting copper to zinc)
   b. What to look for when creating the circuit (i.e. light out of the LED, sound from the bell)

Transition

Organise participants into groups and hand out materials when ready.

Hands On Experimenting

Let participants complete the experiment. It may be pertinent to assign each participant a task (one does wires, other screws, etc.) to guarantee that everyone is involved equally in the experiment.

Note: Some students may be confused by the complexity of the circuit or may require assistance when struggling with the muscular and fine motor control requirements of the task.

Experiment Instructions:

1. Prepare the fruit for this project by rolling them to make them juicier.
2. Stick 1 zinc electrode all the way into each of the lemons to be tested.
3. Place 1 copper electrode on the opposite side of each lemon.
4. Secure one alligator clip to the copper strip on one lemon and the alligator clip on the opposite end of the same wire to the screw on a different lemon.
5. Continue these connections until all lemons are connected in a circular circuit and two ends of the wires with alligator clips are left open to connect to a power source.
6. Connect the open alligator clips to the LED light bulb or the bell (note that there is a positive and negative connection and if it does not work, the connections need to be reversed).
7. Observe or listen to what happens.

Extra Time

Add all of the participants' lemon batteries together in a long series connection (positive terminals to negative terminals) and in parallel connections (positive to positive and negative to negative) to see how it impacts the emission of light from the LED bulb.

Clean Up

1. Have participants take out wires and bring up used lemons.
2. Have participants rinse the zinc screws and copper wires in the trays.
3. Collect materials and compost used lemons.

TROUBLESHOOTING

- The circuit is broken if one of the alligator clips has slipped off of one of the copper wires or zinc screws.
- If a lead connects copper to copper or zinc to zinc, the circuit will be incomplete. Make sure all connections run from copper to zinc in a big circle.
- On the bell and light bulb, the connections will each receive a positive or negative charge. If the connection is not working, reverse it.

ELECTRIFYING THE FUTURE

SCIENCE BACKGROUND

To create a circuit, you require a current source, conductors, and a load. In this instance, our current source are our lemons. Lemons can be used to produce electricity because they contain electrolytes (acidic solution) that reacts with the zinc anode and copper cathode, loosening the extra electrons in the zinc and sending them through the electrolyte to the attractive copper cathode[1]. For electricity to be created, the battery requires a circuit to allow the free flow of electrons to power a 'load'. In this case, our conductors are our Alligator Clip Leads. These help the electrical potential generated by the zinc and copper to flow within the lemon, from one lemon to another, and eventually to power the 'load', which in this case, is a bell and a mini-LED light bulb.

Commercial batteries work on the same principles as the lemon battery, but at a different scale. For instance, lead-acid batteries have layers of lead-dioxide (the negative cathode) and metallic lead (the positive anode) stacked beside each other, and are bathed in a sulphuric acid electrolyte. Power output of these batteries is determined by the difference in potential of the cathode and the anode, with the capacity of a battery to be determined by the capacity or ability of the electrodes to hold a charge[2].

[1]Buddies, S. (2024, February 20). Generate electricity with a lemon battery. Scientific American. https://www.scientificamerican.com/article/generate-electricity-with-a-lemon-battery/

[2]Found at: https://www.sciencedirect.com/science/article/pii/S1369702115003181#:~:text=The%20energy%20density%20of%20a,the%20cathode%20and%20the%20anode.

CURRICULAR OUTCOMES

(Intermediate) The following outcomes are projected to directly relate to the following lesson. Detail can be added to the lesson to match a specific unit plan or extend the learning of the experience. Please note that this list may not include all relevant outcomes.

Grades 1-8

A1.3 use a scientific experimentation process and associated skills to conduct investigations

A3 demonstrate an understanding of the practical applications of science and technology, and of contributions to science and technology

A3.1 describe practical applications of science and technology concepts in their home and community, and how these applications address real-world problems

C1.1 assess the impacts on society of devices that use the properties of light or sound, or both

C2.1 demonstrate an understanding that energy is the ability to move or change something

Grades 4-8

C2.4 use the particle theory to describe how different factors affect the solubility of a substance and the rate at which it dissolves

Grades 1-6

D1.1 assess the impacts of machines and their mechanisms on the daily lives of people in various communities