IoT4Ag
The Internet of Things for Precision Agriculture
an NSF Engineering Research Center

Potato Battery

Lesson Plan for Grade 10, Chemistry

Estimated activity time: 50 minutes

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OVERVIEW & PURPOSE

Students will use their knowledge of how electricity works to build an electric circuit using potatoes as the sole power source.

EDUCATION STANDARDS

Next Generation Science Standards (NGSS)

HS-PS1-3. Plan and conduct an investigation to gather evidence to compare the structure of substances at the bulk scale to infer the strength of electrical forces between particles.

HS-PS1-6. Refine the design of a chemical system by specifying a change in conditions that would produce increased amounts of products at equilibrium.

PREREQUISITES

1. Previous lessons on the nature of the atom and what electrons are. Here is a lesson plan that covers the prerequisites: Atomic Configuration—Building Atoms.

OBJECTIVES

1. Students will be able to design and construct a circuit that optimizes the voltage to a LED light bulb powered by potatoes.

MATERIALS NEEDED

1. Potatoes
2. Alligator clips
3. Voltage meter (must have one per group; the more you have, the better your engagement)
4. Aluminum foil
5. Copper metal plugs
6. Zinc coated/stainless screws or nails
7. LED bulb

VOCABULARY

1. Series: The positive terminal of one battery is connected to the negative terminal of the next battery.
2. Parallel: The positive battery terminals are connected together.
3. Power: The amount of work carried out per second.
4. Voltage: Differences in potential (or electric state) related to the electrical forces that push charges through a conductor.
5. Electron: Stable negatively charged subatomic particle.
6. Anode: An electron where oxidation occurs; positive charged anode.
7. Cathode: Electrode where reduction occurs; usually the negative electrode.
8. Circuit: The path followed by an electric current.

ACTIVITY

1. Break students into groups of 2 or groups of 4 with 2 sets of materials.
2. The teacher will provide a brief review of the vocabulary and overarching concepts in the lab. This will be done via a PowerPoint/Google Slides presentation. The presentation will also introduce the lesson objective and lesson challenge: to see if a light bulb can be powered on by a potato?
3. Students will first be asked to measure the voltage in different circuits using the potatoes as a power source, but change the metals used as the anode and cathode. Students will experiment by changing the different metals and connecting them using the alligator clips. They will record their findings on their graphic organizer.

4. Students will then be asked to set up a circuit with the most voltage from the potato based upon their findings from experimenting with changing the anode and cathode.
5. After optimizing the anode and cathode choices, students will be re-introduced to the lesson challenge. Students will be allowed to test their "optimized" circuit with an LED bulb. Students will not be able to light their bulb using the power from 1 potato alone, so they will next investigate methods of combining multiple power potatoes together. In framing the lesson challenge, it may be helpful to tell students that the LED needs over 2 volts of current to successfully light the LED bulb. (Teacher note: regardless if the students set up the next steps in series first or then in parallel, the amount of potatoes necessary should be more than 2.)
6. Students will next be asked to construct a circuit with 2 potatoes connected in series and measure the voltage of the circuit. (Pictures will be provided to assist with demonstrating to students what series and parallel circuits are)
7. Next students will construct a circuit with 2 potatoes connected in parallel and measure the voltage of the circuit.
8. Lastly students will be allowed to further experiment until they can successfully light their LED bulb.
9. After successfully making the circuit light up the LED, students will complete their reflection questions. These questions will probe what the students determined regarding what happened when they used the same anode as cathode, the nature of the cathodes and anodes and what happens to the voltage when the circuit is in series as opposed to parallel.

ASSESSMENT

Each team should be able to explain the "route" they took in constructing their circuit in order to make the LED light up. This explanation should include why they did not make certain choices.

REFLECTION/MODIFICATIONS

1. Student groupings and roles/jobs (leader, recorder, etc.) can be modified or more clearly defined to help with more easily distracted students or students who need more structure.
2. As an extension: more metals can be added to the 3 suggested in the materials. These were chosen for the sake of ease for the students to manipulate them.

3. Similar to the above prompt this lab was originally designed to use both a lemon/baking soda half cell and a potato as the 2 half cells of the battery. This could be put back in. It was originally taken out due to time constraints and clean up factors. Additionally other fruits and vegetables could be added to this experiment as well.
4. As another extension: the students could be provided with potatoes that have been cooked or heated in different ways and then allow them to test them to further optimize the circuit.
5. In addition to disclosing or not disclosing the necessary voltage for the LED bulb, the teacher can provide multiple different LED bulbs to the students with different voltage specifications.
6. The culminating goal could be changed to be sort of STEAM art project where students construct an OLD or an "organic light display."
7. Additionally, this could be done as a dry run once and allow students to repeat with students planning how they would modify the procedure.

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