

Michael Knapp, Hardin Valley Academy, Knoxville, TN

THRESHOLD ELECTRICITY LESSON

OBJECTIVES

11th & 12th Grades AP Environmental Science

Students will be able to:

- Explain critical terminology: current, voltage, amperage, watts, and ohms in applicable and relevant settings
- Demonstrate ability to correctly use a voltmeter by successfully measuring amperage and voltage of both packaged and homemade batteries
- Use the engineering process to design and construct a low wattage battery
- Explain how a battery works by correctly labelling a diagram of a battery

OVERVIEW

This lesson plan is designed to aid AP environmental science (APES) students get up to speed on threshold concepts which are critical to understanding electricity and energy storage during the APES energy unit. The context for the lesson is that junior/senior APES students were likely last exposed in a limited capacity to related electricity and chemistry concepts as freshmen and sophomores during physical world concepts and chemistry classes 2-3 years prior. Therefore the aim of this lesson is to briefly revisit these ideas and thereafter deepen their understanding in this and the following lesson.

ENGINEERING CONNECTIONS

In this lesson students will define and state the problem to be solved as clearly as possible. In this lesson the essential problem is – how to design and test batteries that can aid in the storage of energy generated by renewable sources.

Students will begin the process of producing different solutions. They will assess possible solutions to determine which ones best meet the criteria and constraints of the problem.

LESSON OUTCOMES

Students will demonstrate effective voltmeter use to successfully measure battery performance.

Students will be able to collect and organize appropriate experimental data from the analysis of battery performance.

REFERENCES

National Research Council (NRC) 2012. A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas. Committee on a Conceptual Framework for New K-12 Science Education Standards. Board on Science Education, Division of Behavioral and Social Sciences and Education. Washington, DC: The National Academies Press.

MATERIALS

- Multimeter
- Test Lead Set with Alligator Clips
- Wire stripper
- 9v batteries
- 9v battery clip with leads
- Low volt filament bulb with an E10 base
- E10 mini bulb mounts
- One 3/4-inch-wide strip of copper
- Electrical tape
- Zinc strip 100mm x 19mm
- Glass Jars – Mason or Ball wide mouths
- E10 1.2V / 0.3A 0.36W Miniature low voltage LED light bulbs can of soda, another electrolyte or weak acid

PROCEDURES

10min - “What’s happening when bulb is lit with battery?” Discussion facilitated around concepts of **amperage**, **voltage** and the combination of the two and its unit the **watt**. The teacher should discuss with students how a flow might be slowed to touch upon the concept of **resistance** which is measured in **ohms**.

15min - Critical Analogies – “Can you devise, illustrate and discuss an analogy that would explore what is happening when the battery lights the bulb?”

10min - Wrap up video & worksheet - Water pumping as electricity and battery analogy

20min - Students explore current, amperage, voltage using voltmeter and alkaline batteries

30min - Set up first basic battery cells using copper, zinc as electrodes inside jar. Measure baseline outputs with air and water first before proceeding to other solutions.

5min - Review of terms and brief preview/tease of next lesson

Key closure questions:

What is the battery’s source of the amperage and voltage?
Where are the electrons coming from and where are they going?

