Off the Grid Unit

Lesson 2: Activities and Assessment of Vocab and Units

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DESCRIPTION: This lesson is intended as a way to check for student understanding regarding the content presented in the previous lesson of this unit. The assessment takes place in two parts: a written assessment of content-related vocabulary and concepts as well as a hands-on section intended to discern whether they can correctly use a multimeter. Each of these assessments focuses on their understanding of units and their application to circuitry. By requiring students pass this section before moving forward, it ensures that they can efficiently collect data independently in the remaining sections of this unit as well as increase the longevity of the equipment used in this process.

GRADE LEVEL(S): 7-12

SUBJECT AREA(S): Electrical and Energy Vocab from a Physics perspective

ACTIVITY LENGTH: 2 days or 2 hours

LEARNING GOAL(S):

1. Students will be able to define voltage, current, power and energy as it relates to electricity.
2. Students will be able to define electricity and have the units for all the above terms in their Journals.
3. Students will be able to set up multimeters for voltage and current and will be assessed on this.

NEXT GENERATION SCIENCE STANDARDS:

- HS-PS3-1. Create a computational model to calculate the change in the energy of one component in a system when the change in energy of the other component(s) and energy flows in and out of the system are known.

- 4-PS3-2. Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.

COMMON CORE STATE STANDARDS:

- N-Q 2. Define appropriate quantities for the purpose of descriptive modeling. __
- A-SSE 1.a. Interpret parts of an expression, such as terms, factors, and coefficients.
- N-Q 1. Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays. __

Materials List

- Multimeters (at least 1 per 2 students but you will assess each student individually)
- Journals

Vocabulary

- Voltage
- Current
- Resistance
- Power
- Energy
- Energy Transformation
- Efficiency
- Series
- Parallel
- Fuse
- DC and AC
- Amperes
- Volts
- Joule
- Coulomb
- Watt
- Volt Amp

Lesson Details

Planning and Prep

You will need to go over the vocab and units in particular. Treat units as a fraction and show how units can cancel. This is simple but a “new” concept to most students and is commonly referred to as *dimensional analysis.* Eliciting background knowledge of dimensional analysis that students apply in everyday life may help illustrate the concept (e.g. if you’re driving 60 mph, how far do you travel in 1 minute? In other words, how fast are you driving in miles per minute?).

You will need multimeters and copies of the written assessments. This activity is meant to follow Off the Grid Lesson 1 where the students have spent time using the meters to measure current and voltage, as well as done some power calculations for solar modules.

This activity follows an exploration of multimeters in Lesson 1: Electrical Energy and Solar Module Efficiency. This lesson (Lesson 2) is aimed at ensuring that students are properly using vocabulary associated with electricity fundamentals. Formative assessments should be done at the end when the instructor chooses student pairs break off into groups and discuss all of the topics below. Students should take notes on their own responses in their journals. After 15-20

minutes of pairs discussing topics, the instructor should randomly choose a pair to answer something from below – after letting the students in the pair give their answer, the instructor randomly chooses another student to agree/disagree or add to the original statement. Possibly one more student is chosen, or a vote is then taken. The instructor should gauge student responses to get a feel for how the class is doing.

Student Background

Students participating in this lesson should be familiar with the following:

- How to use the multimeters
- Units of **Voltage** and **Current**
- Energy and Power for electrical circuit
- Concepts from Off the Grid Lesson 1

Educator Background

Educators leading this lesson should be familiar with all of the information in the student background, with the confidence to troubleshoot and answer student questions as they arise.

Lesson sequence

This lesson contains numerous assessments at determining whether students are ready to continue with the unit, based on their knowledge thus far of electricity fundamentals and circuitry.

Written Assessment #1: Defining and Explaining Concepts

Below is a written assessment to gauge student understanding of the content covered in Lesson 1 and this lesson. This can be used both in conjunction with or as an alternative to the second assessment:

1. Explain **voltage**. Give an example and explain what the units are.
2. Explain **current**. What is it? What are the units? (Perhaps have them provide an analogy)
3. Explain **power**. What is it? Write the formula for power. How is it related to time, voltage, energy and current?
4. Explain **energy**. What is it? Why should the power company really be called the energy company?
5. Explain **energy transformation.** What is its significance in circuitry? Create an example of energy transformation. What are two ways of writing the units for energy?
6. What is efficiency? Write a formula for efficiency. Explain how to find efficiency if you know the power, or energy of a device that is transforming energy in order to run another device. Give an example with values that you make up.

Next is a matching exercise where students should be able to match units with the associated concept.

Written Assessment #2: Matching Vocabulary with Units

Match units and the Concept – some units can be written in more than one way

Voltage	**$Energy_{out}/Energy_{In}$**
	Ampere or Amps
Energy	**(no unit associated with this concept)**
	Coulombs/(second)
Power	**VoltAmp/(second)**
	Watts x (seconds)
Efficiency	**Joules/Coulomb**
	Volts
Current	**Joules/(second)**
	$Power_{out}/Power_{In}$
	Joules

Hands-on Assessment: Correctly Using the Multimeter

Lab Assessment #1: Proper meter care, and use

Description: Each student will be given a hands-on assessment in setting the meter up to measure voltage and current in a circuit that supplies energy to a 12V car phone charger while a phone is charging. This is a Pass/Fail assessment – if a student fails one of the assessments, they will need to work on their skills and wait until the teacher does a second round for all those who did not pass. This is time consuming, so it is good to have students working on something, possibly creating data tables for labs in section OTG-6.

1. Student can turn meter on. □ Pass □ Fail
2. Student can set up the meter and demonstrate proper use of the scales to measure the voltage across 1 AA battery and a battery having a voltage up to 12 Volts (transistor 9V battery or car battery or series AA battery pack). Student will need to write down voltages with units for each battery:

   1AA Battery Voltage_____ Battery #2 Voltage _____
   □ Pass □ Fail

3. Student can show how to set the meter leads up for measuring current up to 10 Amps – student must show proper handling of the leads so as not to damage internal wires.

   □ Pass □ Fail

4. Student can demonstrate how to insert the meter leads into a circuit to measure current, and successfully record a current value with units. □ Pass □ Fail

5. Student can show how to turn meter off when done, and put leads back into a voltage reading position, and carefully coil leads around meter and place back into proper storage container. □ Pass □ Fail

After passing the unit vocabulary assessment and all 5 hands-on steps above, the student is ready to continue to the next lesson. This may take an extra day and students who do well on this assessment should be encouraged to work with students who are struggling.

Teacher Tips: It is important to spend some time on units. The Important Units and Formula charts can be very helpful to show that each of the electrical terms are made up of individual units. Voltage is a very abstract concept, but can be thought of as potential – voltage measuring the potential for a charge to perform work--the more voltage or higher the voltage, the more work can be done. This can be thought of as dropping a ball from different heights – the higher you drop it, the more work it does when it lands (gets a little confusing if you consider air resistance, though it does work on the air), or think about throwing a ball – the faster you throw it the more work it can do (Energy is the ability to do work). This is perhaps a better analogy as more voltage will give an electron a higher speed.

Side Note: While we often simplify circuits as electrons physically moving around the circuit, physical electrons actually travel slowly. It is the electric field that supplies the force to push electrons that travels at close to the speed of light (this is also known as the “signal”). Increasing voltage increases the speed that the actual electrons can travel and the more **Energy** they can transform.

Students should know that power is just energy per time, which is demonstrated by multiplying voltage and current, giving you energy/time or Joules/second:

Energy is the ability to do Work

Energy = Work = Force x Distance = Newtons x meters = Joule

$P = E/t$ = Joule/sec

$P = VI$

V = Joules/Coulomb

I = Current = Coulombs/sec

VI = (Joules/Coulomb)(Coulombs/sec) = Joules/sec

Assessment

Students should not continue in this Unit until they can pass the hands-on assessment. The written assessment can be done with teacher discretion.

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