

ENERGY USE AND DELIVERY – LESSON PLAN 3.2

Electrical Circuits

This lesson is designed for 3rd – 5th grade students in a variety of school settings (public, private, STEM schools, and home schools) in the seven states served by local power companies and the Tennessee Valley Authority. Community groups (Scouts, 4-H, after school programs, and others) are encouraged to use it as well. This is one lesson from a three-part series designed to give students an age-appropriate, informed view of energy. As their understanding of energy grows, it will enable them to make informed decisions as good citizens or civic leaders.

This lesson plan is suitable for all types of educational settings. Each lesson can be adapted to meet a variety of class sizes, student skill levels, and time requirements.

Setting	Lesson Plan Selections Recommended for Use
Smaller class size, higher student ability, and /or longer class length	<ul style="list-style-type: none"> The “Modeling” Section contains teaching content. While in class, students can do “Guided Practice,” complete the “Recommended Item(s)” and any additional guided practice items the teacher might select from “Other Resources.” NOTE: Some lesson plans do and some do not contain “Other Resources.” At home or on their own in class, students can do “Independent Practice,” complete the “Recommended Item(s)” and any additional independent practice items the teacher selects from “Other Resources” (if provided in the plan).
Average class size, student ability, and class length	<ul style="list-style-type: none"> The “Modeling” Section contains teaching content. While in class, students complete “Recommended Item(s)” from “Guided Practice” section. At home or on their own in class, students complete “Recommended Item(s)” from “Independent Practice” section.
Larger class size, lower student ability, and/or shorter class length	<ul style="list-style-type: none"> The “Modeling” Section contains teaching content. At home or on their own in class, students complete “Recommended Item(s)” from “Independent Practice” section.

Electrical Safety Reminder: Teachers should remind students that electricity is dangerous and that an adult should be present when any recommended activities or worksheets are being completed at home. Always obey instructions on warning labels and ensure one has dry hands when touching electronics or appliances.

Performance Objectives

By the end of this lesson, students will be able to:

- Describe how electricity is measured in homes (kWhs).
 - Use and understand math prefix kilo-.
 - Convert watts to kW and kW to watts.
 - Find kWh, using base-ten multiplication.
 - Solve real-world word problems using watts, kW, and kWhs.
- Read a home electric meter, using place value of thousands, hundreds, tens, and ones.
- Explain how electricity in a closed circuit can produce heat, light, sound, and magnetic fields.

Public School System Teaching Standards Covered

State Science Standards

- AL 4.1.1 4th
- KY-SC-P-ET-U-5 3rd
- KY-SC-P-ET-U-3 5th
- MS GLE 10b 5th
- NC 4.P.3.1 4th
- TN 0407.12.2 4th
- TN 0407.12.3 4th

Common Core Mathematics

- AL 3.NBT.1 3rd
- AL 3.NBT.2 3rd
- AL 3.NBT.3 3rd
- AL 4.MD.1 4th
- AL 4.NBT.1 4th
- AL 4.NBT.5 4th
- AL 5.NBT.1 5th
- AL 5.NBT.2 5th
- AL 5.MD.1 5th
- AL 5.MD.5 5th
- GA MCC3.NBT.3 3rd
- GA MCC4.NBT.1 4th
- GA MCC4.NBT.5 4th
- GA MCC5.NBT.1 5th
- GA MCC5.NBT.2 5th
- GA MCC5.NBT.7 5th
- GA MCC5.MD.1 5th
- GA MCC5.MD.7 5th
- KY 3.NBT.1 3rd
- KY 3.NBT.2 3rd
- KY 3.NBT.3 3rd
- KY 4.MD.1 4th
- KY 4.NBT.1 4th
- KY 4.NBT.5 4th
- KY 5.NBT.1 5th
- KY 5.NBT.2 5th
- KY 5.MD.1 5th
- KY 5.MD.5 5th
- TN 3.NBT.1 3rd
- TN 3.NBT.2 3rd
- TN 3.NBT.3 3rd
- TN 4.MD.1 4th
- TN 4.NBT.1 4th
- TN 4.NBT.5 4th
- TN 5.NBT.1 5th
- TN 5.NBT.2 5th
- TN 5.MD.1 5th
- TN 5.MD.5 5th

I. Anticipatory Set (Attention Grabber)

? Essential Question

How is electricity measured?

II. Modeling (Concepts to Teach)

A circuit is a way of routing electricity along a path. Electricity derives from electrons, the negatively-charged particles in an atom, moving from one place to another, occurring almost instantly. So, when someone flips on a switch, he/she is completing a pathway or an **electric circuit**, allowing a **current**, or flow of electrons, to travel through the wires.

In order to make a circuit, the following is needed:

1. **Conductive material** (Metal wire. The wire is surrounded by rubber or plastic because those materials make good insulators. Insulators are materials through which electrons have a difficult time flowing. They protect people from dangerous flows of electricity going through the metal.)
2. **Voltage source** (battery). Voltage is the force that drives current through the circuit.
3. **Light bulb, fan, heater, buzzer, etc.**
4. **Switch** (to be able to turn it on and off).

<http://science.howstuffworks.com/environmental/energy/circuit.htm>

An electric circuit is, in many ways, similar to a circulatory system. Blood vessels, arteries, veins and capillaries are like the wires in a circuit. The blood vessels carry the flow of blood through a body. The wires in a circuit carry the electric current to various parts of an electrical or electronic system.

The heart is the pump that drives the blood circulation throughout the body. It provides the force or pressure for blood to circulate. The blood circulating through the body supplies various organs, like your muscles, brain and digestive system. A battery or generator produces **voltage** – the force that drives current through the circuit.

To teach to the Math and Reading/Language Arts Common Core Standards:

- Together, read the sections “Watts are like miles-per-hour” and “Watts measure power – kilowatts-per-hour measure energy” from the website: <http://www2.buildinggreen.com/blogs/what-watt-anyway-understanding-energy-and-power-metrics>
- Review (or teach) mathematical prefixes centi-, deci-, and kilo- using website: <http://www.factmonster.com/ipka/A0774340.html>. Teach: Kilowatt is 1000 watts
- For more math practice with math prefixes, go to <http://www.aaamath.com/mea212x2.html>.
- Read and model the math problems from the section “Measuring Energy” at: <http://www.explainthatstuff.com/electricity.html>.
- Electricity is measured in kilowatt-hours (kWh). Teachers copy the following explanation and examples on the board: One kWh of energy is equal to 1000 watt-hours and will power a 100 watt light bulb for 10 hours (100 watts x 10 hours = 1,000 watt-hours = 1 kWh). Teachers can refer to “So What is a Kilowatt Hour?” for additional examples to write on the board. http://www.duke-energy.com/pdfs/MyHER_What_is_a_Kilowatt-Hour_Energy_Chart.pdf
 - Ceiling Fan – 75W x 1 hour = 75 watt-hours = 0.075 kWh
 - Portable heater – 1500W x 1 hour = 1500 watt-hours = 1.5 kWh
 - Microwave Oven – 1000W x 1 hour = 1000 watt-hours = 1 kWh
 - Television >50” Plasma – 480W x 1 hour = 480 watt-hours = 0.48 kWh
- Work similar math problems together, using properties of place value and values of 10 (Ex: 60 watts x 10 hours = 600 watt-hours = .6 kWh)

III. Checking for Understanding

Teachers can ask students these questions to determine understanding of concepts

REMEMBER	What do the terms watts, kW, and kWh stand for and what do they measure? (Class discussion)
UNDERSTAND	Explain what a kWh is. Work example math problems to find using values of 10 and/or 100 using multiplication and division. (ex: 40w x 100 hours = 4000 watt-hours which is = 4 kilowatt hours) (Class discussion)
ANALYZE	Why would a house or apartment use more kW's at certain times of the day than others? (Ex: Cooking dinner when everyone is home versus around 1:00 p.m. when everyone is at school or work.) (Class discussion)
EVALUATE	How could we decrease kW's at these high-energy times? (Class discussion)



IV. Guided Practice Ideas

Recommended Items

Simple Light Circuit Experiment (see below)

Experiments

- Simple Light Circuit Experiment: <http://52brandnew.com/2013/04/10/new-experience-13-the-simplest-circuit/>
- Circuit Building with Play-dough Experiment: <http://b-inspiredmama.com/2013/05/kids-circuit-building/>

Games

- Interactive Games: <http://www.sciencekids.co.nz/gamesactivities/electricitycircuits.html>

Other Resources

For Math and Reading/Language Arts Common Core Standards

- Discuss and review terms: watts, kW, and kWh. Teachers write the following on the board and review: Electricity consumption is measured in kilowatt-hours (kWh). One kWh of energy is equal to 1000 watt-hours and will power a 100 watt light bulb for 10 hours ($100 \text{ watts} \times 10 \text{ hours} = 1,000 \text{ watt-hours} = 1 \text{ kWh}$).
- Learn to read a home electric meter. Watch “Reading your Electric Meter” video: <https://www.youtube.com/watch?v=I6UPkncvFhw> to learn more about watts and kW and kWh, and how to read your home electric meter.
- Then, go to: <http://www.fplsafetyworld.com/?ver=kkblue&utilid=fplforkids&id=16234>. Work some example meter readings together, do “Meter Reader Quiz 1 and 2.”
- See lesson 3.4 for explanation of how “power” is used to measure the rate of energy use and how it is related to kWh.

V. Independent Practice Ideas

Recommended Item

Home Experiment: Create a closed circuit using household items: (see below)

Other Resources

Personal Practice

- Writing Activity: Teachers write the following questions on the board and ask students to copy and answer the questions on a sheet of paper: What would happen if we had an open circuit? Why must the circuit be closed?

Practice That May Involve Parents or Guardians

- At-home Checklist: Teachers instruct students to find things in the home that produce heat, light, magnetic fields, and/or sound with electricity (one example of each). Write them on a sheet of paper and label if they produce heat, light, etc.
- Home Experiment: Create a closed circuit using household items. <http://www.youtube.com/watch?v=Rzsognkt290>
- At-Home Activity for meter reading: <https://www.youtube.com/watch?v=I6UPkncvFhw> (meter reading worksheet provided)



Grade 3

- Go to <http://www.unitedpower.com/mainnav/yourhome/meterread.aspx> and take the quiz on reading the meters. Then, record the place value of each number.

VI. Assessment

These items provide a check for understanding so teachers can easily determine whether concepts need to be reinforced. These items can be graded, if desired.

- At-Home Activity for meter reading (meter reading worksheet provided)

VII. Materials Needed

The following materials are needed for the **Simple Light Circuit Experiment** in “Recommended Items” in Guided Practice.

- Small Light bulb
- D battery
- Wire

VIII. Closing the Lesson

In addition to the Essential Question shown below, teachers can reference Performance Objectives at the top of the Lesson Plan.

Essential Question

How is electricity measured?

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METER READING WORKSHEET FOR ELECTRICAL CIRCUITS LESSON 3.2

Meter Reading

NAME: _____

Instructions: For 5 consecutive days, go outside to your electric meter of your home or apartment and read it and record the kWh. Refer to the following for additional information:

<https://www.youtube.com/watch?v=l6UPkncvFhw>.

Day	Date	Time	kWh
Day 1 (start period)			
Day 2			
Day 3			
Day 4			
Day 5 (end period)			

How much energy did you use from the start period to the end period? (Hint: subtract end period reading from start period reading.)
