# Web Unit Plan

**Title:** Light It Up: *How can I learn about the world around me?*

**Description:** You rely on electricity every day for lighting your house or watching TV, but have you ever wondered where it comes from? Student-scientists investigate the different kinds of electricity and discover how this valuable resource is supplied. Using series and parallel circuits, students creatively engineer an electronic quiz or game board to showcase their learning for a Game Day design challenge.

## At a Glance

**Grade Level:** 4-6

**Subject sort (for Web site index):** Science

**Subject(s):** Science

**Topics:** Electricity

**Higher-Order Thinking Skills:** Application, Analysis, Synthesis, Evaluation

**Key Learnings:** Static Electricity, Current Electricity, Circuits

**Time Needed:** 3 weeks, 60-minute daily class periods

## Unit Summary

Students investigate the role of electricity in their environment, particularly how it is created and conducted through circuits. They learn to create series and parallel circuits while identifying and explaining the relationship between the necessary components. Students will design a procedure for testing the conductivity of various classroom objects as they discover the properties of conductors and insulators. A final unit project requires students to apply their knowledge of current electricity, circuits, conductors, and insulators while working to design and engineer an electronic game board. Students also evaluate electricity as a natural resource and discuss electricity from a global perspective.

## Curriculum Framing Questions

### Essential Question

- How can I learn about the world around me?

### Unit Questions

- Is electricity our most valuable resource?
- How can different kinds of circuits be used to make life easier?

### Content Questions

- How does electricity travel?
- Where does electricity come from?
- How do series and parallel circuits work?

## Assessment Processes

View how a variety of student-centered assessments are used in the *Light It Up* Unit Plan. These assessments help students and teachers set goals; monitor student progress; provide feedback; assess thinking, processes, performances, and products; and reflect on learning throughout the learning cycle.

## Instructional Procedures

### Part 1: Introducing the Unit

**Unit Introduction**
Generate student excitement for the upcoming Electricity Unit with a fun activity that is sure to pique their interest. This can be completed as a whole group or in small groups of 3-4 students. Pass out the Shocking Truths about Electricity activity sheet and ask students to discuss each item. As a group, have them select the 5 items that they believe are *true* and the 5 items that they believe are *false*. Follow up with a class discussion and encourage each group to explain their thinking. Note any misconceptions that will need to be addressed later in the unit as you announce the answers using the Teacher Key. Post the misconceptions somewhere in the classroom and return to them periodically throughout the unit to revise students' thinking.

**Building Background Knowledge**
Ask students to think through a typical day and brainstorm a list of all the ways they encounter electricity. Next, ask them to consider daily life for Pioneers and Native Americans prior to the discovery of electricity. Facilitate a class discussion around the question, *How is your life different because of electricity?* Help students realize the valuable role of electricity in our daily lives and consider how our lives would change significantly without it. Share experiences with an electricity black-out or loss of power from a storm.

**Gauging Student Needs**
Begin by asking students, *Where does electricity come from? How is electricity created?* Use class discussion to begin assessing student background knowledge about electricity and circuits. In addition, the Electricity Pre-Assessment asks students to build a circuit that will light up a lightbulb and then explain how it works. Note that students are given extraneous components in the toolbox and not all pieces should be used to build the circuit. Throughout the unit, gauge learning needs by completing the Unit Assessment Checklist for each student and use the results to help guide and determine your unit content.

### Part 2: Building Electricity Concepts

**Exploring Static Electricity**
Begin the lesson by dividing the class into small groups and giving each group a deflated balloon. Present a challenge: *Without using any additional materials from the classroom, how could you get your balloon to stick to the wall exactly four feet off the ground?* Take anecdotal notes on students' understanding as they work on this challenge.

After providing ample time for inquiry and experimentation, perform a class demonstration by rubbing an inflated balloon against a student's hair and then holding it near a wall. Challenge students to not just describe what is happening, but also hypothesize about their observations. Ask students, *"What is causing the balloon to stick to the wall? Which type of electricity is being created? What do you think would happen if I rubbed this balloon against a desk first? How about a sweater?"* Explain how the balloon picks up extra electrons when it is rubbed against a student's hair, making the overall charge of the balloon negative. When the negative balloon is placed on the neutrally-charged wall, the electrons in the balloon attract the protons and make the surface of the wall positive. A key understanding here is that opposites attract. The force of attraction created between the negative charges in the balloon and the positive charges on the wall causes the balloon to stick. The charge on the protons and electrons provides the basis of understanding static electricity. Depending on your students' background knowledge, you may need to review the concept of protons, neutrons, and electrons during this lesson. For additional support resources, visit these websites:

- Library of Congress Science Mysteries: How Does Static Electricity Work?
- Science Made Simple: Static Electricity
- PBS Kids Zoom Activities: Static Electricity

Discuss with the students, *Do you think there are different types of electricity?* Explain that this demonstration showed them the concept of *static electricity*. Another type of electricity, *current electricity*, will be introduced later in the unit. Follow up the balloon demonstration with a PhET science simulation, Balloons and Static Electricity. Using an interactive whiteboard or computer projector, show students how to complete the simulation. Ask students to explain how the interaction between positive and negative charges effects how the balloon behaves in relation to the wall, the sweater, and another balloon. If possible, allow each student ample time to explore the simulation on their laptop computer or in a computer lab.

By now, students should understand that *static electricity* is created when electrical charges build up on the surface of a material. They should also be able to explain that opposite charges attract while like charges repel. As students have seen in the PhET simulation, static electricity is usually caused by rubbing materials together. The result of a build-up of static electricity is that objects may be attracted to each other or may even cause a spark to jump from one object to the other. Ask students to brainstorm other ways that they have encountered static electricity.

Another PhET science simulation effectively demonstrates how static electricity buildup can create an electric spark. In John Travoltage, students see how charges created from a foot rubbing against a carpet can build up inside the body until an object (for example, a doorknob) transfers these excess charges. Ask students to compare the two simulations: *What science ideas are similar in both demonstrations? How are they different? How can static electricity be useful in real life?* (photocopiers, spray painting car parts, pollution control).

### Getting Connected with Simple Circuits

Building upon your students' knowledge and experience with static electricity, explain that another type of electricity is called *current electricity*. Unlike static electricity, which is produced by the charges created from rubbing materials together, current electricity is produced by moving electrons through a conductor.

Explore the flow of electric current by first showing students the components of a simple circuit. Prior to this lesson, collect the materials needed to build a simple circuit that will light a lightbulb. To do this, you will need:

- Battery
- Lightbulb
- Wire or alligator clips
- Battery holder (optional)
- Breadboard (optional)

Detailed instructions for building a simple circuit can be found at http://www.ehow.com/how_5090988_make-simple-circuit.html.

Ask your students to identify the different parts of a *simple circuit*. Explain that a simple circuit is a closed path through which electricity flows. The flow of electrons through a conductor is what creates current electricity. To demonstrate this idea, ask your students to place a light bulb directly on top of a battery and hypothesize why the bulb does not light up. Explain that the *flow* of electrons is what creates the electricity needed to light the bulb.

Now, ask students to direct you and help you light the bulb using a battery and wire in a simple circuit. The Circuit Handout details and illustrates each component of an electric circuit. *Note:* At this point, it is dangerous to let students simply experiment with creating an electric circuit before they have the proper knowledge needed to stay safe. To maintain the inquiry and thoughtfulness of the lesson, while also maintaining safety, it is best to let the students lead you in designing one circuit in front of the class.

When students have a basic understanding of simple circuits, it's time to challenge them to design their own! On laptop computers or in a computer lab, help students navigate to Circuit Construction Kit, a PhET simulation where they can experiment with the various components of a simple circuit. One unique advantage is that the simulation gives students the ability to experiment with an unlimited number of supplies in a safe environment that will not spark or overheat if the circuit is overloaded. Therefore, when playing with the simulation, encourage students to experiment with more complex and creative circuits while using scientific terminology to describe their designs. Hand out the Circuit Construction Kit Handout (Part 1) to help guide and assess their understanding.

*Optional*: Advanced students may benefit from exploring the Circuit Construction Kit (AC+DC). The addition of capacitors, inductors, and AC voltage sources will challenge their understanding and construction of electric circuits.

**Turn On the Light: Series and Parallel Circuits**
Challenge your students' thinking by asking them to observe and count the number of items in the classroom that are currently consuming electricity and ask, *"Do you think each item in this classroom receives electricity through a simple circuit? Why or why not? What would be some problems with this model? How can we control the*

*amount of electricity and where it travels?"* Use this class discussion to introduce the concept of series and parallel circuits.

On laptop computers or in a computer lab, help students navigate back to Circuit Construction Kit. As before, students will use the various components to test and build their own circuits. Ask each student to arrange their materials in a way that will light 3 light bulbs in a row, or *series.* Encourage students to explain their thinking using correct terminology and their knowledge of simple circuits. Use scaffolding and guiding questions to help students discover how to create a *series circuit*. Then, ask students to sketch their circuit on the Circuit Construction Kit Handout (Part 2) and list the key characteristics of a series circuit.

Next, challenge students to arrange their materials in a way that will light 3 bulbs using 3 different wires that run *parallel* to one another. Again, students will sketch their circuit on the Circuit Construction Kit Handout (Part 2) and list the key characteristics of a parallel circuit.

After ample time for exploration and experimentation, ask students to apply their knowledge of series and parallel circuits to discover important differences between the two. Encourage class discussion through questioning:

- What are the similarities between series and parallel circuits? What are the differences?
- Which type of circuit do you think would be more useful for lighting things in your house?
- Which type of circuit do you think would be more useful for supplying electricity to electronics in your house? Why do you think this?
- When would you choose a simple circuit over a series or parallel circuit?
- What are some real-life examples of series and parallel circuits?

**Exploring Conductors vs. Insulators**

An important piece of understanding current electricity is exploring *conductors* and *insulators*. First, review previous learning by asking students, *"What are the components of a circuit? What role does each component play?"* After reminding students of the role of wire in a circuit, ask them to apply their knowledge to the following questions:

- Can electricity flow through anything?
- What materials allow electricity to flow through?
- What materials do not allow electricity to flow?
- Why is this important?

Pose the problem, *How can we identify objects that will allow electricity to flow and objects that will not allow the flow of electricity?* Next, introduce the terms "conductor" and "insulator" with a whole-group demonstration. For this role play, choose five students to be part of a copper wire. Tell them that they represent the atoms in the wire and place them about 3 feet away from each other in a row. Either the teacher or another student can play the role of an electron that is part of an electrical flow, easily weaving between the atoms of the wire and thus conducting electricity. Explain that the copper wire is a *conductor* because it allows the flow of electricity. Then ask five other students to be the atoms in a piece of paper. Place these students shoulder to shoulder in a row. When the electron (another student) tries to get through, it gets blocked by the atoms and therefore the flow of electricity is stopped. Explain that a piece of paper is an *insulator* because it prevents the flow of electricity.

After the whole group demonstration, direct students to their laptops or a computer lab for Will It or Won't It?, a simulation that allows students to test the conductivity of various household items in a virtual environment. This simulation is part of Intel®'s The Journey Inside, a collection of interactive online lessons for students to learn about technology, computers, and society.

Another resource for exploring conductors and insulators is the PhET Conductivity simulation. Students can interact with the controls to experiment with conductivity in metals, plastics, and photoconductors. The flow of electrons is illustrated to help students visualize why metals conduct electricity and plastics do not. The Conductivity Handout will help guide and assess students' understanding.

**Part 3: An Electricity Project**

**Building an Electronic Quiz or Game Board**
In the final unit project students apply their knowledge of current electricity, circuits, conductors, and insulators while working to design and engineer an electronic quiz or game board. Their game is shared with other classrooms as part of a Game Day design challenge.

Explain to the students that they will design a board that provides the user with instant feedback about their answer using a light bulb, buzzer, or similar device. The user interacts with the game board by selecting a question and an answer, receiving immediate feedback on whether their answer is correct or incorrect. Behind the scenes, under the quiz board, is a network of circuits that use conductors and insulators to connect each question with the corresponding answer. View the student sample quiz board for an example. Students may choose any content area for their board, or you may wish to work with another teacher to create an interdisciplinary project. For example, you might require your students to create a game board that ties into a current unit of study in their social studies classes. On Game Day, invite students from other classes to come and try out the electronic game boards. Challenge your students to design a complex and creative game that will interest and engage their visiting peers. Another option is to hold a Game Night and invite parents to the school to celebrate the students' learning.

A Project Checklist will provide clear expectations and guidelines for students as they begin to design their board. In addition to designing a functional quiz or game board, students will be required to write up an explanation of how it works using correct terminology learned throughout the unit.

Students are assessed according to the functionality of their game board, creativity, complexity, and knowledge of conducting electricity through series and parallel circuits. Use the Project Rubric to assess learning and determine how well each student met the unit goals and objectives.

### Part 4: Unit Wrap-Up

Wrap up the unit by handing back the unit pre-assessments. Ask each student to revise their thinking and make corrections to the circuit they attempted to design prior to the unit. Use the same Unit Assessment Checklist to measure student learning gains. Address any remaining misconceptions or questions that remain. Encourage students to reflect upon their learning by answering the following discussion questions in a writing journal:

- How has your thinking about electricity changed?
- Do you think electricity our most valuable resource?
- Is there a limit to the amount of electricity we have?
- Do you think that electricity is a renewable resource?
- Why do you think that some countries have more electricity than others?
- How would you describe your learning processes in this project?
- Did you try anything in this project that was a challenge for you? What did you learn from that experience?

If time and student interest permit, you can follow up or extend the unit with Using Electricity on the Job: Why care about Earth?, another unit plan from the Designing Effective Projects collection. In this unit students answer the questions, *Why is electricity important?* and *What jobs use the concepts of electricity in significant ways?* as they develop positive publicity materials that promote and educate others about careers involving electricity.

## Differentiated Instruction

### Resource Student

- Provide guidelines, checklists, and templates to keep students on track and develop self-direction.
- Identify Web and print resources at appropriate reading levels.
- Place all students in small groups where they can ask questions and confirm their understanding with peers.
- Recommend additional projects that match with students' interests.

### Gifted Student

- Ask students to extend their learning with additional or more complex projects.
- Encourage students to take on leadership roles in their groups and in the class.
- Identify more advanced Web and print resources for further exploration.

### English Language Learner

- Locate additional resources, such as Web sites, in the students' native languages.
- Place students in small groups so they can practice communicating in English and can ask questions in a non-threatening environment.
- Use graphic organizers and demonstrations whenever possible to teach concepts.
- Encourage students to use their native cultural and language expertise when creating a project (for example, make a quiz in their native language).

## THINGS YOU NEED

### Assessment Plan

**Assessment Timeline**

**Before project work begins**

- Shocking Truths Activity
- Brainstorming

- Electricity Pre-Assessment
- Unit Assessment Checklist

**Students work on project and complete tasks**

- Observation
- Discussion

- Unit Assessment Checklist
- Project Checklist

**After project work is completed**

- Project Rubric
- Journal Discussion Questions

- Unit Assessment Checklist
- Project Reflection

Students will be assessed throughout the unit with a mix of self-assessment and teacher feedback. Teachers use questioning, discussions, and observations throughout the unit to assess students' understanding of the Curriculum-Framing Questions as well as other important questions about electricity. The teacher and students use the Electricity Pre-Assessment at the beginning of the unit to determine students' prior knowledge about electric circuits, and again at the end of the unit to document what students have learned. In addition, the Shocking Truths About Electricity activity helps the teacher gauge student needs for the unit. Throughout the unit, the teacher uses the Unit Assessment Checklist to track student progress as well as document higher-level thinking skills and active participation. A Project Checklist provides clear expectations and guidelines for students as they begin to design their game board. Additionally, a Project Rubric assesses learning and determines how well each student met the unit goals and objectives through the final project.

## Content Standards and Objectives

### Targeted Content Standards and Benchmarks

#### Oregon Science Standards

4.1P.1 Describe the properties of forms of energy and how objects vary in the extent to which they absorb, reflect, and conduct energy.

6.2P.2 Describe the relationships between: electricity and magnetism, static and current electricity, and series and parallel electrical circuits.

#### National Science Standards

Content Standard B: Physical Science
As a result of activities in grades 4-5, all students should develop an understanding of Light, Heat, Electricity, and Magnetism.

- Electricity in circuits can produce light, heat, sound, and magnetic effects.

- Electrical circuits require a complete loop through which an electrical current can pass.

**Student Objectives**
Students will be able to:

- Generate logical, tentative explanations for electrical phenomena.
- Explain the relationship between protons, electrons, and static electricity.
- Identify the key components of an electric circuit.
- Describe how current electricity is generated within a circuit.
- Compare simple, parallel, and series circuits.
- Explain the role of conductors and insulators in an electric circuit.
- Evaluate the role of electricity and its effect on global livelihood.
- Apply understanding of electrical circuits to create an electronic quiz board.
- Use creative thinking to generate unusual and innovative ideas for explanations and products.

## Technology and Resources

### Internet Resources

- PhET Interactive Simulations
  http://phet.colorado.edu/*
  A collection of science simulations for students, including several on electricity
- Library of Congress Science Mysteries: How Does Static Electricity Work?
  www.loc.gov/rr/scitech/mysteries/static.html*
  A brief description of static electricity
- Science Made Simple: Static Electricity
  www.sciencemadesimple.com/static.html*
  Explanations about static charge and static electricity with connections to atoms and electrons
- Discovery Kids Curiosity Corner: How do electric circuits work?
  http://kids.discovery.com/tell-me/curiosity-corner/science/how-do-electric-circuits-work*
  Explains electric circuits, with links to additional information
- PBS Kids Zoom Activities: Static Electricity
  http://pbskids.org/zoom/activities/sci/staticelectricity.html*
  An experiment that students can do with static electricity
- The NASA SciFiles: Electricity Activities
  http://scifiles.larc.nasa.gov/text/kids/D_Lab/acts_electric.html*
  Links to experiments and simulations that teach about electricity
- How to Make a Simple Circuit
  www.ehow.com/how_5090988_make-simple-circuit.html*
  Detailed instructions for building a simple circuit
- KidsKonnect: Electricity
  http://www.kidskonnect.com/subject-index/15-science/72-electricity.html*
  Selected links to kid-friendly websites about electricity

### Technology—Hardware

- Batteries
- Insulated copper wires
- Battery holder
- Brass battery clips
- Several bulbs
- Breadboard