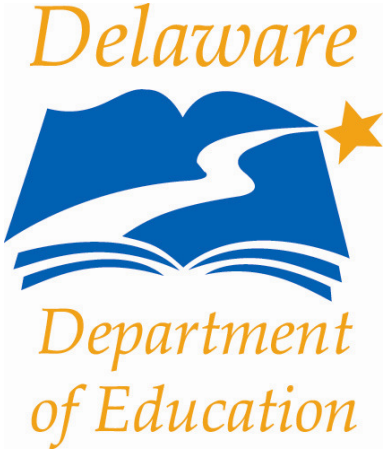
Delaware Science Coalition

Grade 6 Unit Template
Electrical Energy



Preface: This unit has been created as a model for teachers in their designing or redesigning of course curricula. It is by no means intended to be inclusive; rather it is meant to be a springboard for teacher thought and creativity. The information we have included represents one possibility for developing a unit based on the Delaware content standards and the Understanding by Design framework and philosophy.

Unit Summary:

After a review of simple circuits, students are guided to an understanding of series and parallel circuits from an energy perspective. Students are expected to demonstrate their understanding through constructing circuits and explaining how energy moves and changes form in the circuit. The unit also introduces the particle model, by identifying charged particles and moving particles, e.g. charges moving through a circuit.

Stage 1: Desired Results
Delaware Science Content Standards

This course focuses on the Delaware Science Content Standards and Grade Level Expectations in Standards 1 and 3 found on the following web site: http://www.doe.k12.de.us/programs/ci/content_areas/science.shtml

Standard One: The Nature and Application of Science and technology
Understandings and Abilities of Scientific Inquiry:
Students should be able to:

1. Frame and refine questions that can be investigated scientifically, and generate testable hypotheses.
2. Design and conduct investigations with controlled variables to test hypotheses.
3. Accurately collect data through the selection and use of tools and techniques appropriate to the investigation. Construct tables, diagrams and graphs, showing relationships between two variables, to display and facilitate analysis of data. Compare and question results with and from other students.
4. Form explanations based on accurate and logical analysis of evidence. Revise the explanation using alternative descriptions, predictions, models and knowledge from other sources as well as results of further investigation.

5. Communicate scientific procedures, data, and explanations to enable the replication of results. Use computer technology to assist in communicating these results. Critical review is important in the analysis of these results.
6. Use mathematics, reading, writing, and technology when conducting scientific inquiries.

Science Technology and Society:
Students should know that:
1. Advances in technology can expand the body of scientific knowledge. Technological tools allow people to observe objects and phenomena that otherwise would not be possible. Technology enhances the quality, accuracy, speed and analysis of data gathered.
2. Science and technology in society are driven by the following factors: economical, political, cultural, social, and environmental. Increased scientific knowledge and technology create changes that can be beneficial or detrimental to individuals or society through impact on human health and the environment.

History and Context of Science:
Students should know that:
1. Over the course of human history, contributions to science have been made by different people from different cultures. Studying some of these contributions and how they came about provides insight into the expansion of scientific knowledge.

Standard 3: Energy and Its Effects
The Forms and Sources of Energy:
Students should know that:

- 5. Electrical energy is a form of energy that can be transferred by moving charges through a complete circuit.
  Students should be able to:
  - List, as basic forms of energy, light, heat, sound, electrical, and energy of motion.
  - Explain that electrical energy is a form of energy that is transferred through circuits to devices that are designed to make use of this form of energy (e.g., lamps, fans, computers, etc.).

Forces and The Transfer of Energy:
Students should know that:

- 8. Electrical systems can be designed to perform a variety of tasks. Series or parallel circuits can be used to transfer electrical energy to devices. Electrical circuits require a complete loop through which the electrical charges can pass.

Students should be able to:

- Describe the role of electrical charge in circuits by using a model of electrical circuits.
- Relate that electrical energy carried by charges in a circuit is transferred to devices in the circuit and is usually changed into (transformed) different kinds of energy by these devices (e.g., light bulbs change electrical energy into light and heat energy, motors turn the electrical energy into energy of motion). Trace the flow of energy from electrical energy to other forms of energy, such as light. Express whether energy was transferred, transformed or both.
- Construct both series and parallel circuits to investigate and describe how multiple devices in series or parallel (bulbs, motors) perform (dim versus bright, fast versus slow). Describe how the way the devices are connected affects the functioning (i.e., dim versus bright) of the device, and relate this to how much electrical energy is received.

- 9. Moving electric charges produce magnetic fields.

Energy Interacting with Materials: the Transformation and Conservation of Energy
Students should know that:

- 1. Energy can be transformed from one form into another. Energy transformations often take place while energy is being transferred to another object or substance. Energy transformations and energy transfers can be used to explain how energy flows through a physical system (e.g., photosynthesis, weathering, and electrical circuits).

  Students should be able to:

  - Show how electrical energy carried by currents in wires can be used to create magnetic fields. Demonstrate how these fields exert magnetic forces on permanent magnets. Explain how these magnetic forces in electric motors are used to change the electrical energy into the energy of motion.

The Production, Consumption, and Application of Energy

- 2. Technological advances throughout history have led to the discovery and use of different forms of energy, and to more efficient use of all forms of energy. These technological advances have led to increased demand for energy and have had both beneficial and detrimental effects on society.

  Students should be able to:

  - Compare the differences in power usage in different electrical devices/appliances. Discus which devices/appliances (i.e., washer, dryer, refrigerator, electric furnace) are manufactured to require less energy. Select one device/appliance, research different brands and their energy usage, determine which would be the better buy, and report on the findings.

Big Ideas

- For energy to flow in a circuit, the circuit must be a closed loop.

- When two or more devices are included in a circuit their performance will depend upon how they are connected to the energy source (series/parallel) and therefore the amount of energy delivered to each device.
- There are two types of electrical charge, positive and negative. Objects can become "charged" and as a result can attract or repel other objects.
- Negative charges move freely through the circuit and carry energy from the energy source to the device(s) in the circuit. The charges are never used up, nor changed in any way.

Unit Enduring Understandings

Enduring Understanding: Energy takes many forms. These forms can be grouped into types of energy that are associated with the motion of mass (kinetic energy), and types of energy associated with the position of mass and with energy fields (potential energy).

Enduring Understanding: Changes take place because of the transfer of energy. Energy is transferred to matter through the action of forces. Different forces are responsible for the transfer of the different forms of energy.

Enduring Understanding: Energy readily transforms from one form to another, but these transformations are not always reversible. The details of these transformations depend upon the initial form of the energy and the properties of the materials involved. Energy may transfer into or out of a system and it may change forms, but the total energy cannot change.

Enduring Understanding: People utilize a variety of resources to meet the basic and specific needs of life. Some of these resources cannot be replaced. Other resources can be replenished or exist in such vast quantities they are in no danger of becoming depleted. Often the energy stored in resources must be transformed into more useful forms and transported over great distances before it can be helpful to us.

Unit Essential Questions

- How do we know that things have energy?
- How can energy be transferred from one material to another?
- What happens to a material when energy is transferred to it?
- What happens to this energy in a system-where does this energy come from, how is it changed within the system, and where does it ultimately go?

- How does the flow of energy affect the materials in the system?
- What is a "responsible" use of energy? Are there alternative forms of energy that will serve our needs, or better ways of using traditional forms of energy.

Knowledge & Skills

Knowledge:

- Electric circuits contain an energy source and devices that are connected in a complete loop in which the electrical energy can flow. These devices behave differently depending upon how they are arranged in the circuit.
- Particles can either be charged negatively or positively, the negative particles move in the circuit and carry energy from the energy source to a device in the complete loop.
- Objects can be charged by contact when negative charges physically move from one object to another. Objects can also be charged by induction when the negative charges in that object simply move in the object, creating a higher concentration of negative charges in a certain area of the object.
- Charges deliver energy to the devices in the circuit and do not get used up or changed in any way while moving through the circuit. After delivering all of its energy to the devices in the circuit, the charges return to the energy source to gain more energy.
- The energy that is carried from the energy source in the complete loop of a circuit can be changed by the device in the circuit to another form of energy, for instance to light in a bulb, or the movement of a motor.

Skills:

- Classify circuit diagrams as complete or incomplete and justify the classification.
- Describe basic series and parallel circuits and their components.
- Create drawings of series and parallel circuits including those with multiple devices.
- Construct series and parallel circuits that contain two or three devices. Use evidence to prove that the devices are part of the working circuit.
- Compare and contrast parallel and series circuits in terms of energy.
- Troubleshoot an incomplete circuit.
- Compare the power usage in an incandescent and fluorescent light bulb. Discuss which device requires less energy and which would be the better buy.
- Describe electric charges and the forces that charges exert on each other.
- Describe the difference between electrically neutral and electrically charged objects and describe how forces act on objects to

move charges from one object to the other.

- Use a model to explain the importance of electric charge, batteries, and electrical energy in circuits.
- Explain the difference between an electrical conductor and an insulator.
- Predict and describe the performance of light bulbs and motors in series and parallel circuits.

Stage 2: Assessment Evidence

Assessment: The summative assessment for Electric Energy will soon be found on the Department of Education website. **http://www.doe.k12.de.us/programs/ci/content_areas/science.shtml**

Expectations of Students:

- Students will be expected to interpret diagrams of electric circuits and explain how the energy flows in that circuit.
- Students will be expected to construct electric circuits and analyze them from an energy perspective.

Rubrics/checklists for Performance Tasks

Rubrics for the Electric Energy assessment will soon be found at the Department of Education's website: **http://www.doe.k12.de.us/programs/ci/content_areas/science.shtml**

Other Evidence

- Teachers are encouraged to have students keep journals. The journals are used to formatively assess student understanding of the knowledge and skills required. Journal formative questions occur within and at the end of each of the three activities.
- Pre-assessment of student knowledge can occur through the use of a K-W-L chart indicating "what the students think they know", "what the students want to know" and "what the students have learned". As students progress through the unit, they can revise the K-W-L chart to include more questions or knowledge learned.

Stage 3: Learning Plan

Activity 1: A Review of Simple Circuits
In this activity, students will review basic electric circuits and their components. They will use these skills to create simple series and parallel circuits and discuss them qualitatively and quantitatively. This activity is meant as a review to help prepare the students for the two activities that follow in which the science of electric circuits is explored.

Activity 2: Electric Charge, Electric Forces, and Electric Circuits
In the previous activity students reviewed the basics of simple series and parallel circuits. Several questions were raised about the details of how circuits work. In this activity the students will learn a model for understanding and exploring electric circuits. They will also conduct simple investigations to help understand the model better. By the end of the activity the students will have a deeper understanding of how charges and electrical energy are in circuits.

Activity 3: Investigating Series and Parallel Circuits
In this activity, students will need to apply their knowledge about electric circuits (and the model developed in the previous activity to explain how electric energy is transferred and transformed in series and parallel circuits.

Potential Misunderstandings:
Source: Driver, Rosalind, et.al. (1994) Making Sense of Secondary Science. Routledge, NY.

1. In a simple circuit consisting of a battery, bulb, and two wires, students often see the wire leading from the battery to the bulb as important but do not recognize the active part played by the second wire leading from the bulb back to the battery. It is regarded as a "safety wire" (Driver, 1994)
2. In a simple circuit consisting of a battery, bulb, and two wires, students think that the current flows form both ends of the battery to the bulb where it "clashes" (Driver 1994) or leaves the bulb.
3. In a simple circuit consisting of a battery, bulb, and two wires, students think that the first wire carries more current than the second wire and that the bulb "uses up" energy. (Driver, 1994)
4. Students often think of batteries as the source of energy rather than as the cause for electricity to flow. Students think batteries create energy rather than help energy flow.

This unit is meant to be taught as the last unit of three units; *Force and Motion*, *Simple Machines*, and then *Electric Energy*. This unit is meant to take about 3-4 weeks of class time in a suggested 40-55 minute class period. Avoid getting off task or embellishing

activities as this will lengthen the unit and cause problems in completing other 6th grade units. Below is a suggested pacing guide.

Monday	Tuesday	Wednesday	Thursday	Friday
Activity 1: Making Sense of Electric Circuits- Important Parts of a Circuit, Circuits Need a Complete Loop.	Activity 1: Evaluating Simple Bulb Circuits.	Activity 1: Battery and Bulb Holders, Designing Simple Electric Circuits, Building Simple Electric Circuits.	Activity 1:Formative Assessment: Making Sense of What you Learned, Summarizing, Applying.	Activity 1; Investigating Further, Comparing Circuits, Incandescent versus Fluorescent Bulbs.
Activity 2: Making Sense of Electric Forces, Electric Forces and Charged Particles, Identifying Electric Forces.	Activity 2: Making Sense of Charged Objects, Observing the Effects of charged Forces, Electric Forces and Flowing Charges	Activity 2; Sparks and Electric Circuits, Electric Charges flowing through a Circuit, the Role of Batteries, Computer Simulation of Charges	Activity 2; Journal questions, Summary	Activity 2: Charge and Energy, Magnetism and Electricity
Activity 3: Review series and parallel circuits, Build and Observe Series and Parallel Circuits.	Activity 3: Build and Observe Series and Parallel Circuits, Chucky the Charge.	Activity 3: More Complex Circuits	Activity 3: Journal questions, Summary, Efficiency.	Electric Energy- Unit Assessment.

Resources & Teaching Tips
Unit: **Electric Energy.** Delaware Department of Education. 2007.
Accommodation/Differentiation ideas and tips
• The use of group activities throughout this unit enables students with difficulty to gain insight from fellow classmates. Pair students together to best make use of student strengths in different areas. For example, pair a good reader with someone who is good at tactile tasks. • Provide extended time for students whose strength is not in the area of focus. For example, provide extra time for a writing assignment for a student who struggles with writing. • Use a "K-W-L" chart to keep track of "what we know", "What we want to know" and "what we learned". Revise the chart often through out the unit as new questions arise and new knowledge is learned. This will also allow for pre-testing of student knowledge if completed in the student journal. • Use a concept map chart to help students visually connect the concepts in the unit. • Review the previous day's lesson and continuously reinforce concepts from the unit. • Permit the apt student to accelerate their rate of progress and work independently on some content. • Students may use graphic organizers, maps and diagrams to effectively facilitate differing levels of cognitive processing for students of different ability levels.