GENERATIONGENIUS
ALWAYS QUESTION. ALWAYS WONDER.

TEACHER GUIDE

ELECTRICITY AND CIRCUITS
GRADES 6-8

COMMON MISCONCEPTIONS

- **A battery can be a source of charge in a circuit. The charge that flows through the circuit originates in the battery.**
  A battery supplies the energy needed to move a charge from a low potential location to a high potential location. The charge that flows through a circuit originates in the wires of the circuit. The charge carriers in wires are simply the electrons possessed by the atoms that make up the wires.

- **Charge becomes used up as it flows through a circuit. The amount of charge that exits a light bulb is less than the amount that enters the light bulb.**
  Electric circuits are all about energy, not charge. The charge is simply the medium that moves the energy from location to location. The batteries or other energy source does work on the charge to supply it with energy and place it at a high electric potential. Charge at high electric potential will spontaneously begin its very slow migration toward the low potential terminal of the cell. As an individual charge moves through circuit elements such as light bulbs, its electrical energy is transformed into other forms of energy such as light energy and thermal energy. With many, many charges moving through the light bulb at the same time, there is a significant transformation of electrical energy to light energy to cause the light bulb filament to noticeably glow. After passing through a light bulb filament, an individual charge is less energized and at a lower electric potential. The charge completes its slow migration back to the low potential terminal where the electrochemical cell does work on the charge again to move it back up to high electric potential. Once at high potential, the charge can begin its loop again through the external circuit.

- **Materials are either conductors or insulators.**
  Any material can conduct an electric current. Materials are labeled conductors that allow a current to flow easily. Materials are labeled insulators that do not allow a current to flow easily. The difference between conductors and insulators is the degree to which they allow the electric current to flow.

ELECTRICITY

Electricity is briefly defined as the flow of electric charge. Electrons in atoms can act as a charge carrier because every electron carries a negative charge. If we can free an electron from an atom and force it to move, we can create electricity. See this very simplified model of charges flowing through atoms to make an electric current.

STATIC VS. CURRENT ELECTRICITY

Static electricity exists when there is a buildup of opposite charges on objects separated by an insulator. Static (as in "at rest") electricity exists until the two groups of opposite charges can find a path between each other to balance the system out. When the charges do find a means of equalizing, a static discharge occurs. The attraction of the charges becomes so great that they can flow through even the best of insulators (air, glass, plastic, rubber, etc.).

Current electricity exists when charges are able to constantly flow. To flow, current electricity requires a circuit: a closed, never-ending loop of conductive material. The charges are propelled by an electric field. Electric fields describe the pulling or pushing force in a space between charges.

- *Voltage* is the amount of potential energy between two points on a circuit. We need a source of electric potential (voltage), which pushes electrons from a point of low potential energy to higher potential energy.
- *Current* is the rate at which charge is flowing. Current flows from a high voltage to a lower voltage within a circuit.
- *Resistance* is a material's tendency to resist the flow of charge (current).

SERIES AND PARALLEL CIRCUITS

There are two basic ways in which to connect more than two circuit components: series and parallel. The basic idea of a *series* connection is that components are connected end-to-end in a line to form a single path through which current can flow. Components connected in *parallel* are connected along multiple paths so that the current can split up; the same voltage is applied to each component. These are examples of series and parallel circuits.

TEACHER TIPS

- Depending on students' prior experiences, they may need help developing a scientific model to describe how birds can safely perch on high-voltage power lines. To assist students, you could give them a diagram of major components of the system (e.g., wire stretched between poles and bird) and ask them to indicate the flow of the current, trace the circuit, identify conductors and insulators, and indicate the potential difference in voltage and/or current flow.
- Model your thinking as you facilitate students in revising their models after watching the video. Some of these questions may be useful as you facilitate model revisions based on new and additional information:
  - Could someone restate our question (or our charge)? What are we building consensus about?
  - What are some things we think we can say at this point about our anchoring phenomenon?
  - What is our evidence for those ideas (the explanations)?
  - How should we represent it? Are we Ok with that?
  - Do we all agree with that?
  - How are these explanations similar? How are they different?
- Call to students' attention that scientific models are used to describe or explain phenomenon and to make predictions (i.e., students are using their model to predict how a bird could get electrocuted in the Elaborate phase of the lesson).

ABOUT THIS LESSON

This lesson was created by the National Science Teaching Association (NSTA) to pair with the Generation Genius video and support *NGSS*.

They have requested we provide the following background with this lesson:

The Next Generation Science Standards (NGSS) are the national standards on how students learn science, and they are based on contemporary research presented in *A Framework for K–12 Science Education (the Framework).* The shift in science teaching and learning required by the Framework is summarized in this infographic: A New Vision for Science Education.

At the start of each Generation Genius lesson, students are presented with a phenomenon, then they try to explain it. Students will notice they have gaps in their knowledge and ask questions, which motivates them to build ownership of science ideas they need in order to explain how or why the phenomenon occurred. The way students build ownership of science and engineering ideas is through active engagement in the science and engineering practices (SEPs). This process of sensemaking, or doing science to figure out how the world works, is one of the major shifts the *Framework* encourages.

To engage in the SEPs, students should be part of a learning community that allows them to share their ideas, evaluate competing ideas, give and receive critiques, and reach consensus. Students can start by sharing ideas with a partner, then with a small group, and finally, with the whole class. This strategy creates opportunities for all students to be heard, build confidence, and have something to contribute to whole-class discussions. Each Generation Genius lesson provides conversational supports to facilitate such productive student discussions to contribute to sensemaking.

Excited to continue your shift toward the new vision for science education? Check out the Generation Genius Teacher Guide page on the NSTA website for resources and strategies to engage every student in your classroom in **doing** science.