Helpful Review of Science Covered in This Module

Read this information to boost your understanding of the science behind the circuits youth will create. Remember, participants do not need to use these terms when experimenting. Feel free to introduce these concepts only if they if they come up organically. Rather than focusing on teaching scientific terms and concepts, facilitate youth asking questions and making careful observations during each session.

Alligator Clip: A spring-loaded clip with serrated edges that is used for temporary circuit connections.

Battery: A combination of cells in a series. NOTE: In conversation, people use "battery" when they actually mean "cell." Don't get overly technical in these sessions with youth. Allow everyone to use "battery" to mean one cell or a series of cells.

Cell: A single unit that converts chemical energy into mechanical energy. Common cells are known by letters AAA, AA, C and D.

Circuit: A path for electricity to flow. An electrical circuit requires:

- A power source, such as a battery
- A conductor that creates a path for electricity to flow through, such as the wires
- A load that changes electricity into another type of energy, such as a lightbulb

Conductor: Material that allows electrons to flow.

Energy: Scientists define energy as the ability to do work. Modern civilization is possible because people have learned how to change energy from one form to another and then use it to do work. Forms of energy include heath, light, motion, electrical, chemical and gravitational.

Insulator: Material that does not allow electrons to flow freely.

LED: Light-Emitting Diode; a semiconductor device that emits light when an electric current is passed through it.

Load: Any component in a circuit that consumes power or electricity.

Parallel circuits: A circuit with multiple paths for electricity to flow. If each resistor, such as a lightbulb, creates its own circuit, each light will be as bright as if it were the only resistor in the circuit. Parallel circuits allow you to turn on multiple lights in your house without the light getting dimmer each time you turn on an additional light.

Series circuit: A single path for the electricity to flow. If two resistors, such as lightbulbs, are in the series, the lights will be dimmer because they share the electrical current.

Switch: A device in a circuit that causes electricity flow to stop.

Voltage: The amount of force pushing electricity along its path.

What Is Voltage and How Does It Relate to Success With Circuits?

In this session, groups may work with battery holders that hold three or four AA batteries. Using additional batteries in the circuits may overload the LED bulbs and cause them to permanently stop working. That is OK. When this happens, the light will briefly shine and then go out. Youth will need to use a new LED light and decrease the number of batteries they are using to avoid burning out more bulbs.

The reason bulbs burn out when powered by too many batteries has to do with voltage. Voltage refers to the amount of force pushing electricity along its path. To illustrate, a trickle of water can gently water plants, or a pressure washer blast can deep-clean concrete.

In Session 1, circuits required two batteries to light the LED. The AA batteries are labeled '1.5V' or '1.5 volts.' The LED bulbs supplied were intended to operate at 3 volts. One AA battery was not enough to light the bulb, but two AA batteries aligned become one bigger battery whose voltage is the sum of the two cells, or 3 volts.

In Session 3, youth may add additional batteries to their circuits. Three AA batteries deliver 4.5 volts and four batteries deliver 6 volts of power to the circuits. Since the LED was designed to operate with 3 volts, the extra voltage carries excessive heat to the LED light and can melt the solder and the wires.

For more information on this topic, see the video "Voltage Explained – What Is Voltage?" from The Engineering Mindset **(youtube.com/watch?v=w82aSjLuD_8).**

NOTE: *When discussing voltage with youth, emphasize safety and best practices when working with electricity. Remind youth that the wires are sharp and to let go of the wires immediately if they get warm or hot.*

Links to Science and Teaching Resources

FOR STAFF *(Not intended for youth)*

- Stop teaching science vocabulary first: **stemteachingtools.org/brief/66**
- Scientists work in teams: **sustainable-nano.com/2013/06/25/teamwork-wins-why-science-is-not-an-individual- sport**
- Scientists often work in teams and share responsibilities. This helps them be more effective. This aligns with the social-emotional skills you work towards each session: **ncbi.nlm.nih.gov/pmc/articles/PMC3652225**
- Science careers: **chemistryworld.com/careers/the-science-of-team-science/4014201.article**
- Circuitry and electronics extensions for youth:
  - **dkfindout.com/us/science/electricity/circuits**
  - **kids.britannica.com/kids/article/electric-circuit/443114**
- What's a resistor?: **qrg.northwestern.edu/projects/vss/docs/thermal/3-whats-a-resistor.html**
- Conductors and insulators:
  - **dkfindout.com/us/science/electricity/conductors-and-insulators**
  - **nde-ed.org/Physics/Electricity/conductorsinsulators.xhtml**
- Drawing electronic sketches known as schematics: **stemeducationguide.com/simple-electronics-projects**