ELECTRICAL ENGINEERING

This session will present an overview of the electrical engineering discipline and will allow Explorers to conduct a short, fun experiment that is related to electrical engineering.

CATEGORY

- Engineering
- Electrical Engineering

OBJECTIVES

By the end of this session, participants will be able to:

- Define electrical engineering.
- Understand what electrical engineers do.
- Demonstrate key electrical engineering concepts.

SUPPLIES

- Items for Activity 3 (per team of two Explorers)
  - One lemon per team of two Explorers, plus additional citrus fruits if desired
  - One copper nail (2 inches or longer) or penny
  - One zinc nail or galvanized nail (also 2 inches or longer)
  - Small lightbulb (colored or opaque, if preferred) with a 2-inch lead
  - Electrical tape
- Microammeter (optional)
- Suggested website: http://www.bls.gov/ooh/architecture-and-engineering/home.htm

ADVISOR NOTE: Text in italics should be read aloud to participants. As you engage your post in activities each week, please include comments, discussions, and feedback to the group relating to **Character, Leadership,** and **Ethics**. These are important attributes that make a difference in the success of youth in the workplace and in life.

ACTIVITY 1

Introduction: What Do Electrical Engineers Do?

Discuss with Explorers information about the field of electrical engineering and what they could expect if they chose it as a career. The information that follows is from the Bureau of Labor Statistics Occupational Outlook Handbook for Electrical Engineers. (Source: http://www.bls.gov/ooh/architecture-and-engineering/electrical-and-electronics-engineers.htm)

Tell participants: *Electrical engineers design, develop, test, and supervise the manufacturing of electrical equipment, such as electric motors, radar and navigation systems, communications systems, or power generation equipment. Electrical engineers also design the electrical systems of automobiles* *and aircraft.*

Electrical engineers typically do the following:

- Design new ways to use electrical power to develop or improve products
- Perform detailed calculations to develop manufacturing, construction, and installation standards and specifications
- Direct the manufacture, installation, and testing of electrical equipment to ensure that products meet specifications and codes
- Investigate complaints from customers or the public, evaluate problems, and recommend solutions
- Work with project managers on production efforts to ensure that projects are completed satisfactorily, on time, and within budget

Work Environment

Electrical engineers work in industries including research-and development, engineering services, manufacturing, telecommunications, and the federal government. Electrical engineers generally work indoors in offices. However, they may have to visit sites to observe a problem or a piece of complex equipment.

ACTIVITY 2

How to Become an Electrical Engineer

High school students interested in studying electrical engineering benefit from taking courses in physics and mathematics, including algebra, trigonometry, and calculus. Courses in drafting are also helpful, because electrical engineers often are required to prepare technical drawings.

In order to enter the occupation, prospective electrical engineers need a bachelor's degree in electrical engineering, electronics engineering, or electrical engineering technology. Programs include classroom, laboratory, and field studies. Courses include digital systems design, differential equations, and electrical circuit theory.

Important Qualities

- Concentration: Electrical engineers design and develop complex electrical systems and electronic components and products. They must be able to keep track of multiple design elements and technical characteristics when performing these tasks.
- Initiative: Electrical engineers must be able to apply their knowledge to new tasks in every project they undertake. In addition, they must engage in continuing education to keep up with changes in technology.
- Interpersonal Skills: Electrical engineers must be able to work with others during the manufacturing process to ensure that their plans are implemented correctly. This collaboration

includes monitoring technicians and devising remedies to problems as they arise.

- Math Skills: Electrical engineers must be able to use the principles of calculus and other advanced math in order to analyze, design, and troubleshoot equipment.
- Speaking Skills: Electrical engineers work closely with other engineers and technicians. They must be able to explain their designs and reasoning clearly and to relay instructions during product development and production. They also may need to explain complex issues to customers who have little or no technical expertise.
- Writing Skills: Electrical engineers develop technical publications related to equipment they develop, including maintenance manuals, operation manuals, parts lists, product proposals, and design methods documents.

Pay

The median annual wage for electrical engineers was $91,410 in May 2014. The median wage is the wage at which half the workers in an occupation earned more than that amount and half earned less. The lowest 10 percent earned less than $59,140, and the highest 10 percent earned more than $143,200. Most electrical engineers work full time.

ACTIVITY 3

Hands-on Fruit Battery

Ask participants: *Can you name a few items you use often that run on batteries? Have you ever thought about what makes the battery work?*

Have participants share ideas about types of batteries they have used or are familiar with, and ask them how they think batteries work.

Say: *There are many types of batteries that can be used in gadgets of all types and sizes, from a hearing aid or flashlight to a car or even a massive building. A battery is a device that converts stored chemical energy to electrical energy. The chemical energy is most often in the form of liquid electrolytes (in a wet cell battery) or a paste electrolyte (in a dry cell battery). When a battery is connected to an external circuit, electrolytes move as ions within the battery and chemical reactions occur at the positive and negative terminals—the cathode, or positive side (+), and the anode, or negative side (-) on a typical battery. Those reactions deliver energy to the external circuit to power your flashlight or perform whatever other task is needed.*

Ask: *Have you ever heard of a fruit battery? A fruit battery uses an ordinary item you might have in your refrigerator to make your own battery. Today, you'll be working with a partner to create a battery powered by the chemicals in a lemon.*

Procedure

- Have Explorers get in teams of two, and distribute the materials.
- First, have Explorers soften the lemons by placing them on a table, pressing down, and rolling them back and forth several times.
- They should then press the two nails into the top of the lemon about 2 inches apart. Tell them to push the nails until the tips are at the center of the lemon.
- Next, have participants peel the insulation from the bulb's wires and wrap the wires around the heads of the two nails. They may hold the wire in place with electrical tape if needed.
- When the wires are connected, the bulb should light up. If time allows, have Explorers try the same procedure using different types of citrus fruit to compare the results.

Discussion

The acidic content of the lemon helps to conduct the electricity from one nail to the other, so fruits with higher or lower acidity will conduct more or less electricity. The fruit contains positively charged ions. When you inserted the galvanized or zinc nail into the fruit, the negatively charged ions or the electrons started to move from the fruit to the zinc nail thus leaving the protons in the fruit. This transfer of electrons generates electricity as soon as you attach the wires to the nail, and the bulb lights up!

(Source: The lemon battery content is adapted from Explorables.com, https://explorable.com/fruit-battery-experiment.)

ADVISOR NOTE

Some sample questions are below. They are designed to help the participants apply what they have learned to their own interests. You are welcome to use these questions or develop your own questions that relate to your post or specific focus area.

Focusing Questions	▪ *What was the purpose of the activity? Why did we do it?* ▪ *Which parts of today's session did you enjoy most?* ▪ *What new things did you learn?*
Analysis Questions	▪ *How did you use engineering concepts and skills to build your fruit battery?* ▪ *How did you overcome challenges while designing and building your fruit battery?* ▪ *Could you have benefited from having more time to build or test your battery? How would that have helped?* ▪ *Now that you have completed the activity, what else could have been helpful to you in building a better fruit battery?* ▪ *If you had to do this activity again, would you change*

	anything? What would you change and why? ▪ *Why could working on a team be a benefit for engineers?*
Generalization Questions	▪ *What aspects of electrical engineering would you like to learn more about?* ▪ *What subjects in school do you believe you will need in order to pursue a career in electrical engineering?*