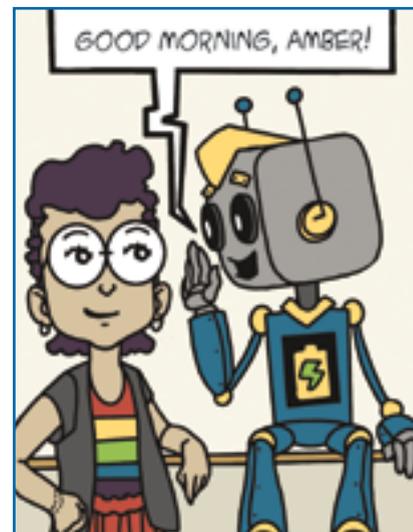
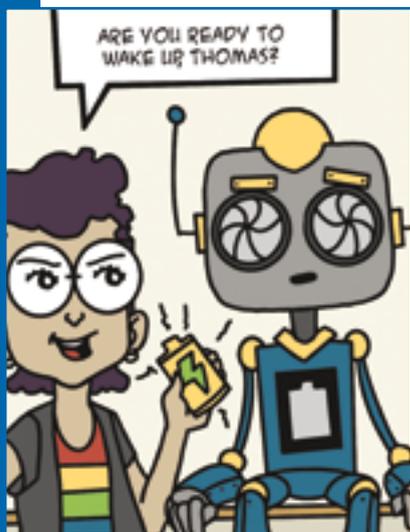


THE POWER OF ZAP!



What is the first thing you did when you woke up this morning? You probably turned on a light or went to the kitchen for breakfast. Maybe someone made you pancakes on the stove or toast in the toaster. Did you watch television or listen to music or use a computer? All of these things required **electricity**.

Electricity is a kind of natural **energy**. Some people think Benjamin Franklin (1706–1790) or Thomas Edison (1847–1931) invented it. But actually, nobody invented electricity. It's been around since long before humans came along.

ESSENTIAL QUESTION

What are some ways electricity is important to our daily lives?

Thousands of years ago, people knew about electricity because they could see it in action. Have you ever seen a **lightning** storm? How might people from the ancient past have explained lightning storms?

ELECTRICITY

WORDS TO KNOW

electricity: a form of energy caused by the movement of tiny particles. It provides power for lights, appliances, video games, and many other electric devices.

energy: the ability to do things, to work.

lightning: an electrical charge from a cloud.

generate: to create something.

technology: the tools, methods, and systems used to solve a problem or do work.

engineering: the use of science, math, and creativity in the design and construction of things.

static electricity: the buildup of an electric charge on the surface of an object.

BCE: put after a date, BCE stands for Before Common Era and counts down to zero. CE stands for Common Era and counts up from zero. This book was printed in 2022 CE.

amber: a piece of fossilized tree sap or resin.

battery: a device that stores and produces electricity using chemicals.

power: electricity made available to use.

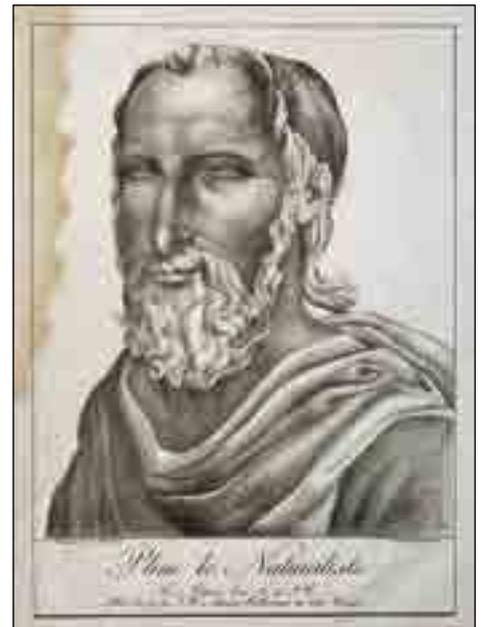
by an electric catfish could help numb a person's pain. Some people even sought this out to help with certain illnesses, such as gout, which causes persistent aches in those who suffer from it. Ancient people didn't know why they felt better after being shocked by an electric fish, but they knew it worked.

Many of the jobs involved in **generating, storing, and using electricity** are **STEM jobs**. **STEM** is an abbreviation for **Science, Technology, Engineering, and Math**. You might also hear it referred to as **STEAM**. The **A** in **STEAM** stands for **Art and Design**.

What about **static electricity**? The ancient Greek scientist Thales of Miletus lived from 625 to 547 **BCE**. He observed that if he rubbed a piece of **amber** with wool or fur, it attracted lightweight objects such as feathers and dust.

What happens when you rub a balloon on your head and stick the balloon to the wall? It stays! We call this static electricity. The ancient Greeks had no name for it.

Ancient peoples found electricity in many different places. Pliny the Elder (23–79), an ancient Greek scientist, observed that being shocked



Pliny the Elder

Credit: Wellcome Library (CC by 2.0)

From early times, scientists around the world studied electricity and how it works. But it's been in only the last few hundred years that we've learned how to harness the power of electricity and make it useful to us.

Animals (including humans!) carry electricity in their bodies. Some animals are able to use that electricity to hunt for food. The electric ray, which is a kind of fish, has a special muscle that acts like a **battery**. It sends out a shock to stun creatures in the water. **See this hunting method in action in this video. How might the fish's environment make this method of hunting possible?**

 Vanderbilt electric eel



ELECTRICITY TODAY

Our modern-day lives depend on electricity. Think about the last time you lost **power** at your home. What was it like? Did you have to cook on a grill outside instead of

Sharks have special electrical senses that help them find a tasty fish snack from miles away.

on the electric stove or in your microwave? What did you do for entertainment when your phone and laptop batteries ran out? Did the food in your refrigerator spoil? Lights, computers, televisions, phones, toys, refrigerators—our world revolves electricity.

on the electric stove or in your microwave? What did you do for entertainment when your phone

ELECTRICITY

WORDS TO KNOW

blackout: a loss of power.

power grid: a system of power plants and circuits.

outlet: a device in a wall that an electric cord plugs into.

appliance: an electric machine used in the home, such as a toaster or washing machine.

engineer: a person who uses science, math, and creativity to design and build things.

electrical engineer: an engineer who designs systems and processes that use electricity.

physicist: a scientist who studies how matter and energy behave within the universe.

electromagnetism: magnetism created by an electric current.

neurologist: a doctor who studies and cares for the human nervous system.

electrician: a person who installs, fixes, or maintains electric wiring systems.

conductor: something that electricity moves through easily, such as copper wire.

insulator: a material that prevents heat, sound, or electricity from passing through it easily.

circuit: a loop that starts and finishes at the same place.

motor: a machine that turns electric energy into motion.

generator: a device that turns motion into electricity.

We can lose power when storms or other forces knock down electric wires or equipment or when too many people are trying to use electricity at the same time. The biggest **blackout** in the world occurred on July 31, 2012, when 640 million people in India lost power. That's about 10 percent of the world's population! Traffic was a mess without traffic lights, construction projects across the country were halted, and doctors couldn't perform surgeries.

Even our own muscles, including our hearts, rely on electric signals within the body to work!

Experts believe that poor equipment plus high demand for electricity stressed the systems to the point of failure. The country is still working to improve and maintain its **power grid**.

A partial blackout in Brazil

Credit: Diego Torres Silvestre (CC BY 2.0)



Safety First

Electricity is incredibly important to our lives, and the way it works is fascinating. But it can also be very dangerous. Coming in contact with even a small amount of flowing electricity can burn or even kill. This is because it can disrupt the electric signals our bodies need to work properly. Always treat **outlets**, plugs, and electric **appliances** with care. And remember, the activities in this book are safe as they are written. Don't be tempted to change them.

Engineers are people who use science and math to design and build things. **Electrical engineers** are people who deal with the technology of electricity. But many other people work with and need to understand electricity in their jobs. For example, **physicists** study how things such as **electromagnetism** affect the world. Doctors called **neurologists** study the electrical signals in our bodies. And, of course, **electricians** work with electricity to keep our homes and schools powered.

In *Electricity: Circuits, Static, and Electromagnets*, we'll learn what causes electricity and the ways it's generated, stored, and used. And we'll learn about the exciting and essential roles it plays in our lives. We'll find out what **conductors** and **insulators** are, how **circuits** work, and the difference between a **motor** and a **generator**. We'll also explore how scientists are trying to generate Earth-friendly electricity and energy resources. Along the way, we'll get to do some fun projects and experiments.

So, get *charged up* and let's explore electricity!

The word *electricity* comes from the ancient Greek word *elektron*. This was the Greek word for *amber*.

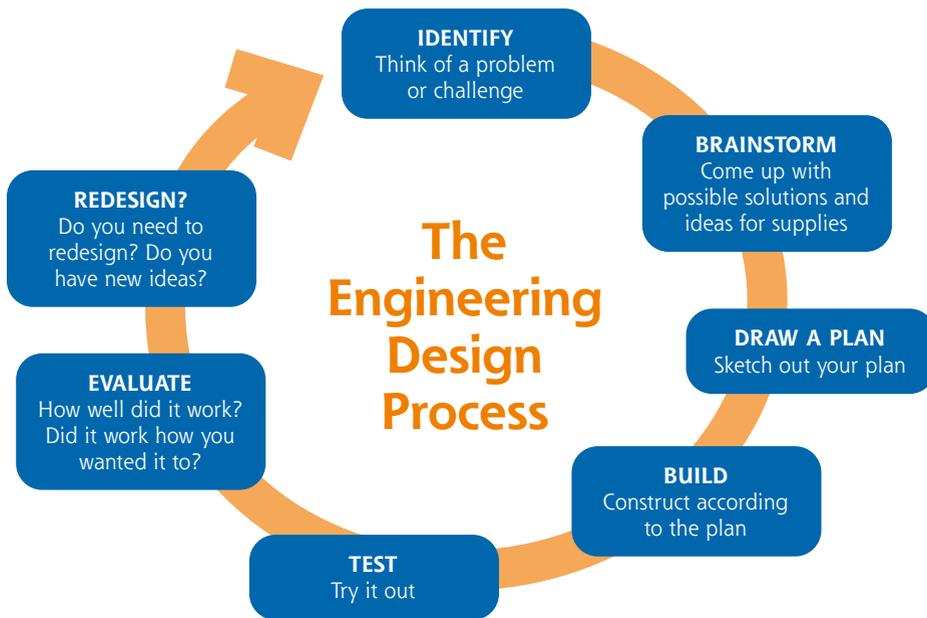


TEXT TO WORLD

Can you come up with solutions to problems caused by having no electricity? Are there other ways to cook? What's your favorite game or activity to do when the lights are out?

Good Engineering Practices

Every good electrical engineer keeps a science journal! In the first activity, you will make a notebook to use as a design journal. Engineers use the engineering design process to keep track of their inventions, and scientists use the scientific method to keep track of experiments.



As you read through this book and do the activities, record your observations, data, and designs in an engineering design worksheet or a scientific method worksheet. When doing an activity, remember that there is no right answer or right way to approach an obstacle. Be creative and have fun!

Each chapter of this book begins with an essential question to help guide your exploration of electricity. Keep the question in your mind as you read the chapter. At the end of each chapter, use your science journal to record your thoughts and answers.

ESSENTIAL QUESTION

What are some ways electricity is important to our daily lives?

CREATE YOUR OWN SCIENCE JOURNAL

Thales of Miletus (**circa** 624–548 BCE), an ancient Greek scientist, did simple experiments involving electricity. But we know this only because other people wrote about it. None of Thales' writings survived. Make sure your own science journal that looks like an electric outlet to record observations and take notes.

► **On the black construction paper, use the ruler and pencil to make four rectangles that are 2¼-inches long and ¾-inch wide.** Trace a circle the size of the quarter. Cut out all of the pieces. Next, cut the circle into two equal semi-circles.

► **Lay one piece of the cardstock vertically.** Using two of the rectangles and one of the semi-circles, create an outlet near the top of the cardstock. Using the remaining rectangles and semi-circle, create a second outlet near the bottom of the cardstock. Glue all the pieces of black construction paper onto the cardstock and let dry. This will be your journal's cover.

► **Sandwich the blank paper between the sheets of cardstock.** The number of pages your journal will have is up to you. You can always add more later. Make sure the pieces of paper and the covers all line up.

► **Use the hole punch to punch three evenly spaced holes along the left side of your journal.** Place a paper brad in each hole to bind the journal together. Now, you're ready to *charge* ahead!

TOOL KIT

- black construction paper
- ruler
- pencil
- a quarter
- 8½ x 11-inch cardstock
- hole punch
- blank paper
- 3 paper brads

Try This!

A scientific method worksheet is a useful tool for keeping your ideas and observations organized. The scientific method is the way scientists ask questions and then find answers. Use the inside pages to make a scientific method worksheet for each experiment.

Question: What are we trying to find out?
What problem are we trying to solve?

Research: What is already known about this topic?

Hypothesis: What do we think the answer will be?

Equipment: What supplies are we using?

Method: What procedure are we following?

Results: What happened and why?

WORDS TO KNOW

circa: around that year.
Abbreviated with a "c."

vertical: straight up and down.

SWITCH IT UP

EXPERIMENT

TOOL KIT

- science journal
- timer

How many times a day do you use electricity? This experiment is a way to get a sense of how much you rely on electricity without even realizing it.

► **To begin, make a prediction about how many times you turn something on or off in one hour.**

This can mean flipping a switch, pushing a button, turning a knob, or pulling on a cord. Record your prediction in a scientific method worksheet in your journal.

► **Next, set the timer for one hour.** Go about your normal routine. Each time you turn something on or off, make a mark in your journal. These marks will be your data, or scientific results.

► **When an hour is up, compare your prediction with your data.** Based on your observations, how much do you rely on electricity?

► **Does your environment effect how much electricity you use?** Make a prediction and try the experiment again while you're at school, a store, or the park. Test your prediction and record your data in your journal.

Try This!

Today, there are many types of switches. For example: push button, toggle (these are the one most commonly used), pull-chain or cord, rocker (flat plates that "rock" back and forth), and dimmer. What kind of light switches are in your home? Observe and record your findings in your science journal.

Who Invented the Light Switch?

The first "quick break" light switch was invented in 1884 by John Henry Holmes (1857–1935), an English electrical engineer. Before this, electricity would **arc** when a switch was turned on or off. This means electricity would flow through the air between conductors. This was dangerous and caused damage to switches. Holmes figured out how to move the conductors apart more quickly, eliminating the arc and making the switches safer to use!

WORDS TO KNOW

arc: a curved path, sometimes made by electricity jumping from one thing to another.