**FACILITATOR GUIDE TO**

**BATTERY STACK**

# DESCRIPTION

In this activity, learners make a voltaic pile, the first kind of battery. The activity is designed to prompt conversation and reflection about responsible innovation, inspired by themes raised in Mary Shelley’s novel *Frankenstein.*

# AUDIENCES

This activity is best suited for ages 7 and up. Younger children can participate successfully with support from an educator or caregiver.

# LEARNING OBJECTIVES

# The primary objective of this activity is to encourage exploration and reflection about responsible innovation. In addition, learners will investigate the following concepts:

# People are creative! We’re always learning more about the world and inventing new things.

* It’s important to think ahead as we study science and make new technologies.
* Mary Shelley’s novel *Frankenstein* was inspired by early scientists who studied electricity.

# MATERIALS

* 8-inch acrylic rod on a stand (1 per station)
* Copper washers (at least 8 per station, 1 with a length of copper wire attached)
* Felt washers (at least 8 per station)
* Zinc-plated washers (at least 8 per station for every 2–3 hours you will do the activity)
* LED bulb, 3mm or 5mm
* Buzzer with wire leads, 3–6v
* Wire leads with alligator clips
* Multimeter
* Vinegar
* Plastic bowl
* Large tray
* Activity booklet
* Sign holder and table sign
* Large plastic tweezers (optional)

Sources and instructions for creating your own kit materials are provided at the end of this facilitator guide.

# PRESENTATION

**Preparation:**

Before doing this activity with participants, go through it a few times. This will ensure you know how to do all the steps and can easily help participants. It will help you work out how to organize the materials for participants.

To familiarize yourself with the activity, use the activity booklet. It provides step-by-step instructions for the activity. It also includes contextual information about Mary Shelley’s novel *Frankenstein* and the questions the story raises for current science and engineering.

**Set up:**

* Pour some vinegar into the the plastic bowl. Put the felt washers in the bowl so they soak up the vinegar. Once they’re thoroughly soaked, you can pour any excess vinegar down the drain. You’ll need at least 8 felt washers for each activity station.
* Get a supply of copper washers. You’ll need one washer with a wire attached for each station, and at least 7 additional washers for each station.
* Get a supply of zinc washers. You’ll need at least 8 washers for each activity station. The zinc washers corrode quickly, so if you are doing the activity for longer than an hour or so, you’ll need extras on hand.
* You can place each acrylic rod on a tray to minimize the mess from the wet washers. (Each rod/tray is one “station.”)
* Set out the other materials near the tray(s). They can be shared across a couple stations.

**Activity flow:**

Open by asking participants if they’ve ever heard of Frankenstein’s “monster.” Share that the original story was written 200 years ago by Mary Shelley, and has been retold many times. Ask if they know what happens in the story, and establish the basic plotline. In the novel, a student named Victor Frankenstein builds a creature from dead body parts, and uses electricity to bring it to life. Unfortunately, Frankenstein didn’t think ahead to what his creature would do, or how he would take care of it, if he succeeded in bringing it to life.

Explain that the author, Mary Shelley, was inspired by real experiments with electricity that were happening during her lifetime. Show participants the materials and ask if they would like to try an early electrical experiment. Share the activity guide with participants so they can follow use the instructions and read the information.

When participants test the LED bulbs, it is important to note which terminal or “leg” of the bulb is positive and which is negative. The longer terminal or “leg” of the LED is its positive side. This side should connect to the base washer’s red wire with alligator clips. An LED will not work if the wrong wire is attached to the wrong leg. If participants are unable to make the LED light up, they may have connected it backwards.

Be sure to ask participants some or all of the reflection questions:

* *Why do you think scientists such as Volta may have wanted to investigate electricity?*
* *Are inventors responsible for the ways people use their inventions?*
* *Is an invention itself good or bad, or does it depend how people use it?*

Finally, return to Shelley’s story. You can ask:

* *How you think Shelley may have felt about the electrical experiments going on during her lifetime?*
* *How would you have felt about them?*

There’s no right or wrong answer to the reflection questions! Everyone can form their own opinions. You can help encourage visitors to develop and share their own ideas by referring to the Conversation Tips guide.

**Clean up:**

* Remove the felt washers from the vinegar and squeeze them out using paper towels. Allow them to air dry overnight before storing.
* Pour excess vinegar down a drain.
* Rinse the rod and dry with paper towels.
* Dry off the metal washers with paper towels.
* Store copper and zinc washers separately.
* Store corroded zinc washers separately from unused zinc washers.

**Audiences:**

Young children and individuals with special needs may need assistance with some steps in this activity.

**Safety:**

* Supervise young children to ensure they do not mouth any materials, as some materials may present choking hazards.
* It is safe to touch the vinegar, but participants should wash their hands afterwards. You may choose to offer large plastic tweezers or disposable gloves, but be aware that these optional supplies will make it more difficult to manipulate the washers (especially for participants with small hands or limited dexterity).

**PROGRAMMING OPTIONS**

This activity can be incorporated into a variety of educational programs, such as afterschool programs, family workshops, and summer camps. In longer program formats, you can use videos and books to familiarize participants with the Frankenstein story:

* The 1931 Hollywood movie *Frankenstein,* directed by James Whale, introduced the world to Boris Karloff’s iconic version of the creature.
* *Frankenweenie* is a 2012 retelling of the Frankenstein story, directed by Tim Burton.
* There are also a many books that share the story, which are appropriate for a variety of audiences.

You can also use videos to provide more information on the experiments of Volta and Galvani:

* [How batteries work](https://youtu.be/9OVtk6G2TnQ) (TED-Ed) provides a brief overview of the electrical experiments of Volta and Galvani and a clear explanation of how batteries work. YouTube: https://youtu.be/9OVtk6G2TnQ
* [Experimento Galvani](https://youtu.be/SoyCgamTdAE) (Matheus Souza) doesn’t provide narration or contextual information, but shows a frog leg twitching when touched by wires. Note that this video may be too gruesome for some participants—preview it ahead of time! YouTube: https://youtu.be/SoyCgamTdAE.
* [How to make a battery by Alessandro Volta](https://youtu.be/c_0N-0lfxpE) (Electric Experiments) shows the assembly and use of a voltaic pile. YouTube: https://youtu.be/c\_0N-0lfxpE.

# MATERIALS INFORMATION

**Sources:**

* Washers are available at hardware or building supply stores. The zinc washers will corrode and need to be replaced frequently, so you’ll need more zinc washers than copper or felt washers.
* Acrylic rods are available online, at scientific or plastics supply stores.
* Multimeters, LED bulbs, and buzzers are available at electronic supply stores. Make sure the buzzer is the type that changes volume with different amounts of voltage (more voltage creates a louder squeal).
* Large plastic tweezers and disposable waterproof gloves are available at educational supply stores. Note that the use of tweezers or gloves are optional. Either of these options will make it somewhat more difficult to slide the washers on the rod, especially for participants with small hands or limited dexterity. Participants can use their bare hands to manipulate the vinegar-soaked felt washers, but they should wash their hands afterwards.
* Cafeteria trays are available at restaurant supply stores.
* All other materials are available at discount stores.
* Print materials for this activity can be downloaded from [nisenet.org](http://nisenet.org/).

**Preparation:**

First time preparation: To prepare the activity materials before doing the activity for the first time, you will need a wire stripper and some extra insulated copper wire.

* Copper washer: To create the base washer for the first pile, use a wire stripper to strip several inches of insulation off a 12-inch length of insulated copper wire. Wrap the exposed wire around a copper washer several times.
* Rod and stand: An acrylic rod that is mounted on a stand is ideal. You can also use a loose rod and beaker: create a stopper at the bottom by wrapping it with electrical tape so the washers don’t slide off the end; and place the rod in a beaker to hold it up. Note that the rod does not need to be acrylic, but can be any non-conductive material that won’t be damaged by vinegar.
* Multimeter: The rubber guards on the multimeter probes are removable. Taking them off may make it easier to measure volts.

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Distributed in collaboration with the National Informal STEM Education Network: nisenet.org



This project was supported by the National Science Foundation under Grant Number 1516684. Any opinions, findings, conclusions, or recommendations expressed in this program are those of the authors and do not necessarily reflect the views of the Foundation.

This is a common activity that exists in many variations. The Frankenstein200 version was adapted from Frogs, Volts, and Vinegar by The Bakken Museum and Build a Better Battery by the Museum of Science, Boston.

Instruction and promotion photos and illustrations by the Science Museum of Minnesota for Frankenstein200.

Portrait of Mary Shelley from Wikimedia Commons. Retrieved from: https://commons.wikimedia.org/wiki/File:MaryShelleyEaston2.jpg

Historic image of an electrical experiment on a corpse from Wikimedia Commons. Retrieved from: https://commons.wikimedia.org/wiki/File:Houghton\_Typ\_815.67.3922\_-\_Les\_merveilles\_de\_la\_science,\_Figuier,\_fig.\_333.jpg

Photograph of voltaic pile from Wikimedia Commons. Retrieved from: https://commons.wikimedia.org/wiki/File:Pila\_di\_Volta.jpg

Historic image of Galvani’s experiment with a frog from Wikimedia Commons. Retrieved from: https://commons.wikimedia.org/wiki/File:Galvani-frogs-legs-electricity.jpg

Photograph of a drone from Wikimedia Commons. Retrieved from: https://commons.wikimedia.org/wiki/File:Drone\_First\_Test\_Flight.jpg