Paper Circuit

Statue of Liberty

STEM Challenge

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About Vivify

Vivify is a team comprised of two Aerospace Engineer friends, Natasha and Claire, who live in Texas. We met as college classmates and roommates at Texas A&M University and later left engineering careers in the Department of Defense and Air Tractor to pursue our passion for STEM education. Learn more of our story here.

Our goal is to bring engineering to life—to vivify learning—for kids of all ages. Please connect with us so we can learn how to better serve your students!

- Natasha & Claire, The Vivify Team

Connect with us for free STEM resources!

Subscribe to our newsletter and receive access to a library of free STEM resources through www.vivifystem.com. Follow us on social media or listen to "The STEM Space" podcast for more resources and ideas. We also welcome you to join "The STEM Space" Facebook group to connect with other educators across the world.

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Next Generation Science Standards

This activity is aligned to the following standards:

3-5-ETS1-1.	Define a simple design problem reflecting a need or a want that includes specified criteria for success and constraints on materials, time, or cost.
3-5-ETS1-2.	Generate and compare multiple possible solutions to a problem based on how well each is likely to meet the criteria and constraints of the problem.
3-5-ETS1-3.	Plan and carry out fair tests in which variables are controlled and failure points are considered to identify aspects of a model or prototype that can be improved.

MS-ETS1-1.	Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions.
MS-ETS1-2.	Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem.
MS-ETS1-3.	Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success.
MS-ETS1-4.	Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved.

4-PS3-2. Make observations to provide evidence that energy can be transferred from place to place by sound, light, heat, and electric currents.

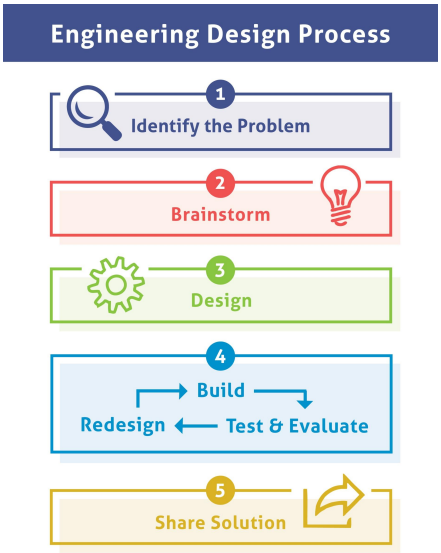
Note to Teachers

ABOUT THIS ACTIVITY

This packet is intended to guide students in elementary, middle, and high school through a design challenge using paper circuits.

This activity is a Stage 2 STEM activity. Learn more about the STEM stages here. Students will:

- Learn about an engineering problem they need to solve.
- Gather materials and brainstorm ideas.
- Draw a design idea.
- Build and test their device. Students will keep making changes and improving their design.
- Share their final design.



Paper Circuit Statue of Liberty Activity

Students will learn about circuits and then create their own miniature Statue of Liberty with a lighted torch. Students are tasked to use the engineering design process to design and build a way to support their statue.

STEM career connection: Architect /Structural Engineer

Real-world connection: The history and engineering of the real Statue of Liberty.

Materials Per Team

Paper Circuit Materials:

- 1 sheet of card stock print-out of Statue of Liberty
- Conductive ¼" copper tape (like this) approximately 2 feet (60 cm)
- LED light (like this)
- 3V Coin battery (like this)
- Index card
- Scissors
- Clear tape (about 6 inches (15 cm))

Design Challenge Materials

- 1 sheet of cardstock
- 4 index cards
- 1 foot (30 cm) masking tape
- 4 craft sticks
- Tape

Note to Teachers

TEACHER INSTRUCTIONS

1. Engage students with a history video about the Statue of Liberty like these:
   - Statue of Liberty Educational Video (2 min)
   - Facts about the Statue of Liberty for Kids (6 min)

2. **Introduce engineering design process** using the poster handout provided. Explain to students that real-world engineers use this process to create engineering designs such as rockets, airplanes, skyscrapers, and computers. More great resources: http://pbskids.org/designsquad/parentseducators/workshop/process.html and http://thekidshouldseethis.com/post/whats-an-engineer-the-engineering-process-crash-course-kids

3. Split students into teams of 2. **Materials:** Supplies listed on the previous page are to be shared in the team. You can substitute for materials available in your classroom. We recommend controlling the amount of materials for students be thoughtful in their designs.

4. **Challenge Background:** Pass out the "The Statue of Liberty" and "STEM Career Connection" handouts. Alternatively, you may choose to display these pages and discuss them as a class. They provide a background on the importance of the Statue of Liberty and a STEM career connected to its construction.

5. **Challenge Overview:** The mission is to design a Statue of Liberty such that it stands up on its own and the torch lights up. You may choose to use the provided printable Statue of Liberty and cut it in half for each student team to use or have the students draw their own. Students must first create a working paper circuit and then use the engineering design process with the included worksheets to design their support structure.

6. **Paper Circuit**: Use the provided circuit handout to explain the basics of an electric circuit and how to create a simple light paper circuit. Pass out the materials needed for this portion of the challenge and have student teams create their circuits to light their torch. Instruct them to draw an outline of their circuit before using the copper tape. They can either keep the light on the back side of the printed statue or poke the light through to the front of the torch. Students may struggle in keeping their copper tape from tearing. Show them how to fold it to make a corner without tearing it.

7. **Structural Design & Build:** Once students successfully light the torch of their statue, they need to use the engineering design process handouts to design and build their support structure. They must brainstorm ideas and draw their design before receiving the additional supplies.

8. ***To make this design activity more challenging for older students, include that students must make the tallest possible free-standing statue by building a pedestal for the Statue of Liberty. You may wish to include other recyclable materials for them to use in their design. Ideas include: pipe cleaners, straws, cardboard, and newspaper.

9. **Test & Share:** Students should be able to demonstrate how their statue lights up and stands up on its own. ***Additionally, students can measure the final height of their statue to compare to other teams. Consider having each team present their design to the class and explaining how they came up with their idea.

10. **Reflection.** Have students answer the reflections questions individually, as a team, or as a class.

Engineering Design Process

1

Identify the Problem

2

Brainstorm

3

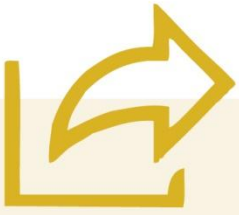
Design

4

Build

Test & Evaluate

Redesign



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Share Solution

WANT MORE STEM?

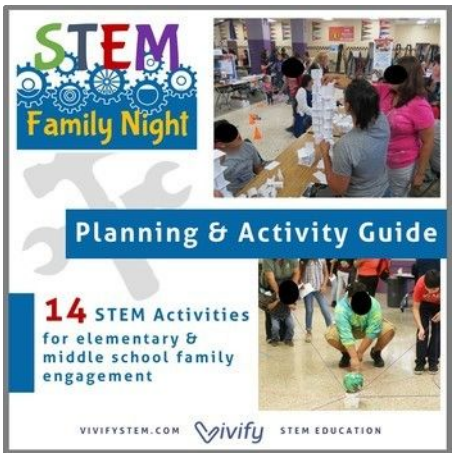
For a complete list of all of Vivify STEM resources broken down by standards, topics, and grade levels, go here: http://bit.ly/VivifyResourceGuide

bit.ly/VivifyMars

bit.ly/Vivifyspacebundle

bit.ly/icebreakerbundle

bit.ly/Vivifycatapult



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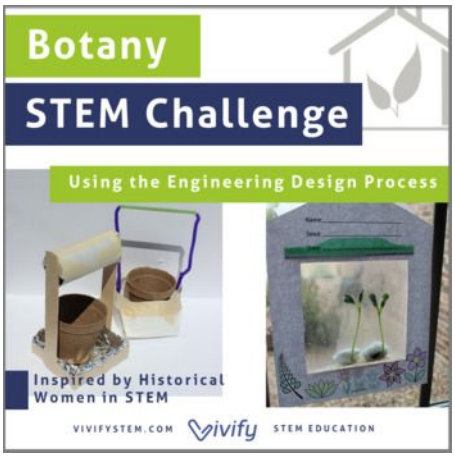

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Vivify's Overview of STEM Education

Successful STEM education is an empowering interdisciplinary approach that brings math and science concepts to life through problems that mimic the complexities and excitement of the real world. STEM revolves around the Engineering Design Process that embraces failure, relies on teamwork, and requires critical thinking and creativity. While exciting, educators often become intimidated as a search for curriculum leads to an overwhelming range of activities from index towers to robotics competitions. At Vivify, we believe that not all STEM is created equal. Educators should adopt a 3 Stages of STEM approach by progressively building towards more complex projects.
To learn more about the 3 Stages of STEM, go here: http://bit.ly/stemstages

The Statue of Liberty

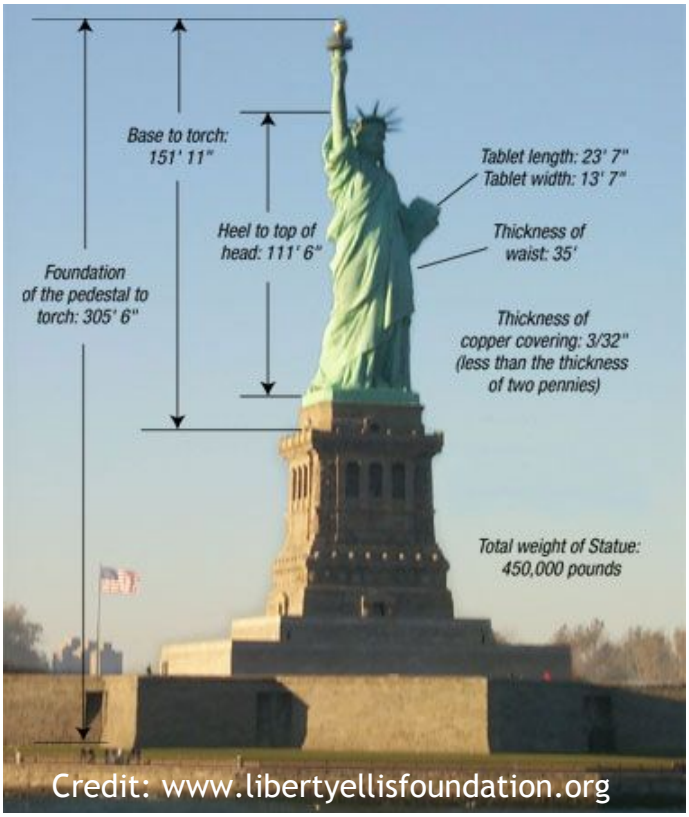
A Historic Monument

The Statue of Liberty was designed by sculptor Frederic Auguste Bartholdi to commemorate 100 years of the United States of America Declaration of Independence. The Statue was named "Liberty Enlightening the World" and was a joint effort between America and France. The American's were to build the pedestal for the Statue to stand upon while the French people were responsible for building and assembling the Statue in the United States.

The massive size of the statue required the assistance of engineer Alexandre Gustave Eiffel (designer of the Eiffel Tower) to address structural issues. He designed the iron pylon and interior skeletal framework that helps the statue to remain standing!

The granite pedestal was designed by American Architect Richard Morris Hunt in 1884.

To bring the statue to the United States where it is on Liberty Island in New York Harbor, the statue was broken down into 350 individual pieces and packed in 214 crates to ship across the ocean. It took four months for the statue to be reassembled where she stands today.



A Symbol of Freedom

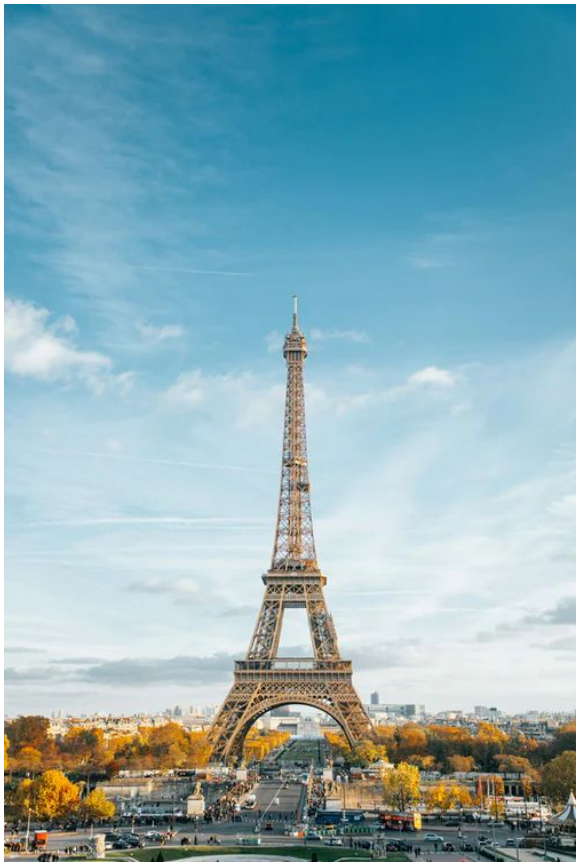
The Statue of Liberty was constructed as a gift from France to symbolize freedom and was dedicated on October 28, 1886. She holds a tablet that reads "JULY IV MDCCLXXVI" which is the date of American independence (July 4, 1776). At the base of the Statue lie broken shackles and chains of oppression and tyranny. The Statue of Liberty's torch lights the way to freedom showing us the path to Liberty.The Statue's current replacement torch, added in 1986, is a copper flame covered in 24K gold. It reflects the Sun's light in the daytime and is lighted by 16 floodlights at night

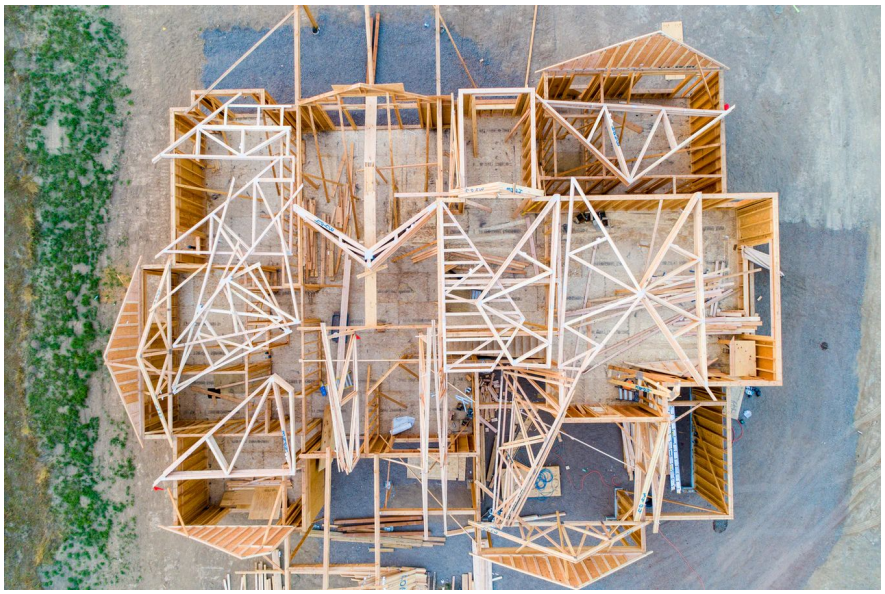
There are seven rays on her crown, one for each of the seven continents, each measuring up to 9 feet in length and weighing as much as 150 pounds! The Statue of Liberty is currently a greenish color, but that wasn't always the case. The exterior copper covering of the Statue of Liberty is 3/32 of an inch thick (less than the thickness of two pennies) and the light green color (called a patina) is the result of natural weathering of the copper from the surrounding salty ocean air.

STEM Career Connection

Architect

Architects plan, design, and oversee the construction of buildings and large structures. They focus on the physical appearance of homes and buildings as well as making sure that they are safe and economical for people to use. Structural engineers may help architects ensure that a building is sturdy and strong enough to support its own weight and the weight of what will use the building. Both architects and structural engineers use drawings to communicate and construct their designs. Gustave Eiffel was considered as both an architect and a structural engineer.

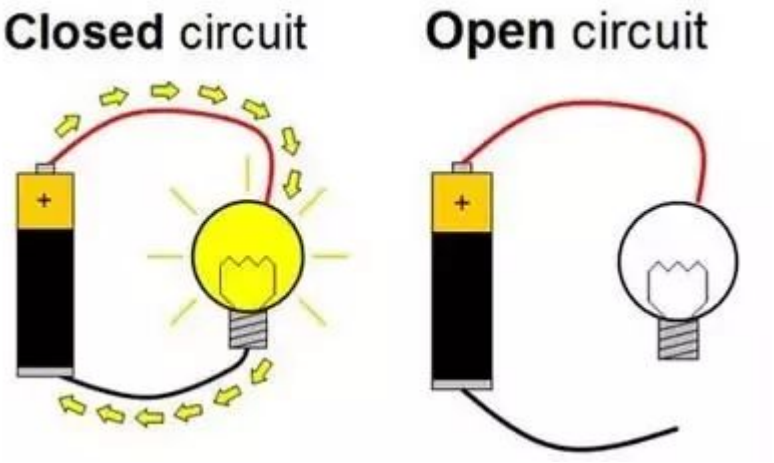




Simple Light Circuit

Circuits

An electronic circuit is a closed path that allows for electricity to flow from one place to another through electronic components such as wires, lights, and switches. A flashlight is an example of a simple circuit that turns on a light.



A **closed circuit** allows for electricity to flow continuously through the circuit and can operate an electrical device or light up a lightbulb.

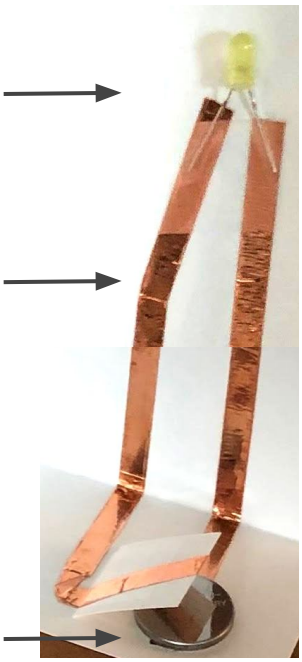
An **open circuit** stops the flow of electricity using a switch or by disconnecting a wire. You open a circuit every time you unplug a device or turn off a lightswitch.

Circuits can be made of many different electronic components. You will be making a paper circuit that will follow the same basic design as a flashlight. Here are the components of your simple light circuit.

A LED (Light Emitting Diode) has two prongs; the long prong is the positive side and the short one is the negative side. These prongs should be connected to the appropriate sides of the battery.

Copper tape works like conductive wire in allowing the electricity to pass from one point to the other. The tape should be bent at turns but **not** cut or the circuit will be broken.

A coin battery provides the right amount of electrical current to light the small LED light. The copper tape must touch both sides (positive and negative) of the battery to complete the circuit. You can create a "switch" by wrapping the copper tape around a paper flap and pushing it down to "turn on" your light.



Tape over the prongs to press them against the copper tape and provide a good connection.

Name: _____

1

Identify the Problem

Design a miniature Statue of Liberty that includes a torch that lights up and can stand on its own.

Constraints

1. Use only the materials provided.
2. Torch must light up and turn off.
3. Statue must be free standing.

2

Brainstorm

What other things stand up on their own?
What materials are available for your design? How will you make the torch light up?

3

Design

Sketch your design idea below.

4 **Build**

5

Test

Time to test your statue! For each trial, complete the table below.

Trial	Torch light up?	Statue stand up?	Write or Draw Improvement Ideas
1	Yes / No	Yes / No	
2	Yes / No	Yes / No	
3	Yes / No	Yes / No	

6

Reflect & Share

1. What did you learn from this challenge?

2. How can your statue be improved?