HIDDEN NO MORE

Facilitation Guide

Light and Energy

MOREHEAD PLANETARIUM+ SCIENCE CENTER

Hidden No More
Facilitation Guide

Introduction

Grant Information

This exhibit is the second phase of a three-phase project connected to the NSF grant #1906686 Hidden No More: Shedding Light on Science Stories in the Shadows. More information about the grant can be found at https://moreheadplanetarium.org/program/special-initiatives-programs/hidden-no-more/

Light and Energy

Phase 2 of the *Hidden No More* exhibit focuses on the science of energy and how this aspect of light can be used for scientific invention and discovery. The exhibit engages visitors in learning about the lives and work of Lewis Latimer, a pioneer of the electric light industry in the 19th century, and Hakeem Oluseyi, a solar explorer in the 21st century. Visitors learn how circumstance, science, and invention connect the stories of these two African American scientists born more than a century apart.

We Need Your Feedback

One of the goals of the grant is to improve upon each proceeding phase. We plan to do this with formal evaluation, but we would also like to hear any informal feedback from your institution's staff. Feedback can be sent to: Michele Kloda (mkloda@ad.unc.edu)

HIDDEN NO MORE

Exhibit Components

Hands-On Activities

Discover the Sun’s Atmosphere	5
Investigate Invisible Light	15
Explore Conductors and Insulators	22
Invent a Switch	31
Sorting Scientists	39

Scientist Videos

Animated Video: Lewis Latimer	43
Documentary Video: Hakeem Oluseyi	45

Virtual Reality Experiences

Lewis Latimer: Electrifying Light	47
Hakeem Oluseyi, Solar Winds	49
Selected Sources	51

HANDS-ON ACTIVITIES

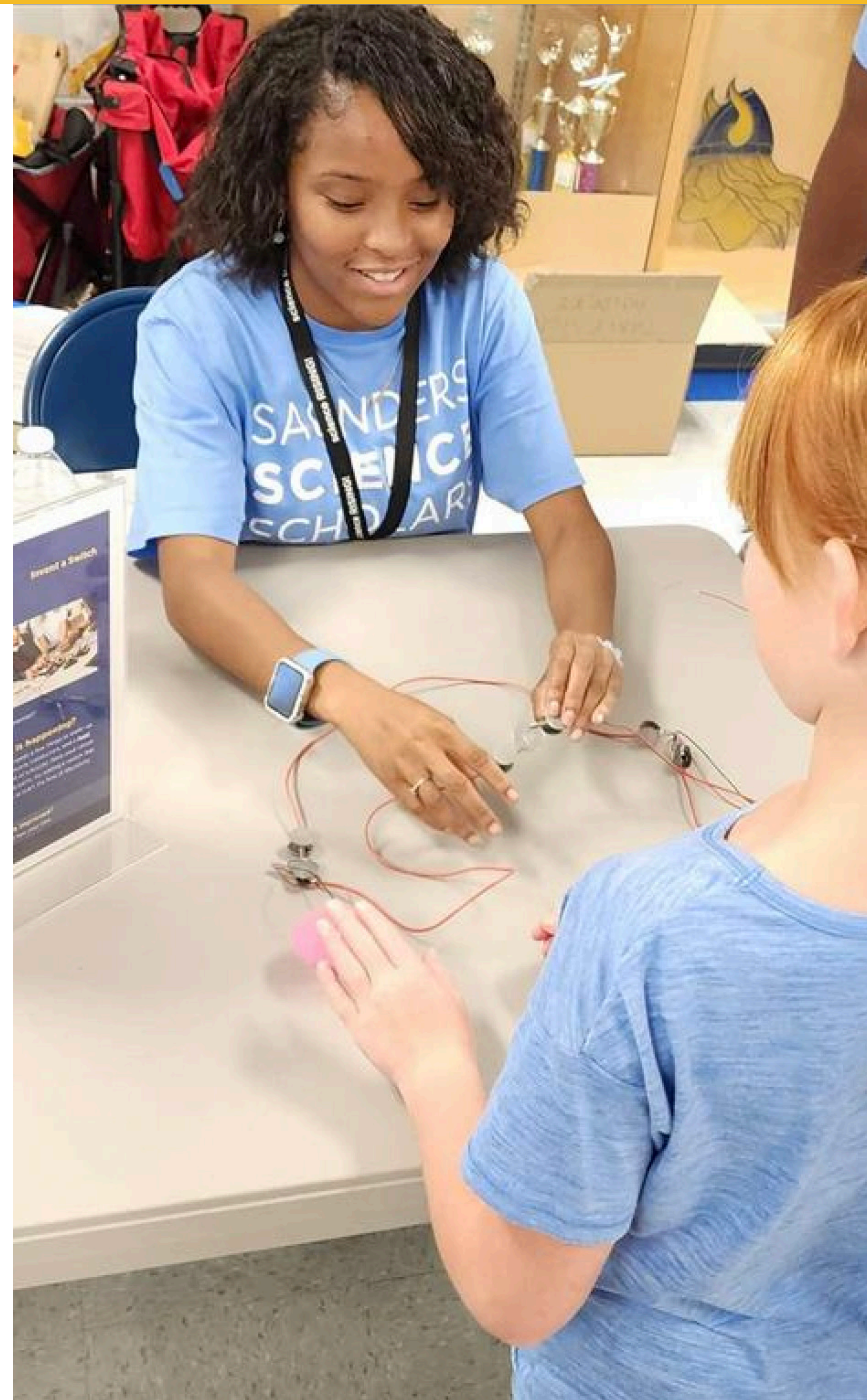
While making their own discoveries and inventions, participants in the following hands-on activities learn about—and learn from—trailblazing scientists Lewis Latimer and Hakeem Oluseyi.

"Discover the Sun's Atmosphere" and "Investigate Invisible Light" connect to Hakeem Oluseyi's work; while "Explore Conductors and Insulators" and "Invent a Switch" relate to Lewis Latimer's work. However, there are connections among them all, as they illuminate *Hidden No More* themes of light and energy, discovery and invention.

These tabletop activities can be set up in a variety of informal STEM learning settings. Assess table height to be sure all your visitors, including those who use wheelchairs, can participate.

Though developed with special attention to engaging middle-school students, the activities can be enjoyed by participants ranging from children of elementary-school age to adults.

RIGHT: A high school student facilitates the "Invent a Switch" activity at a back-to-school event in rural North Carolina.



Discover the Sun's Atmosphere

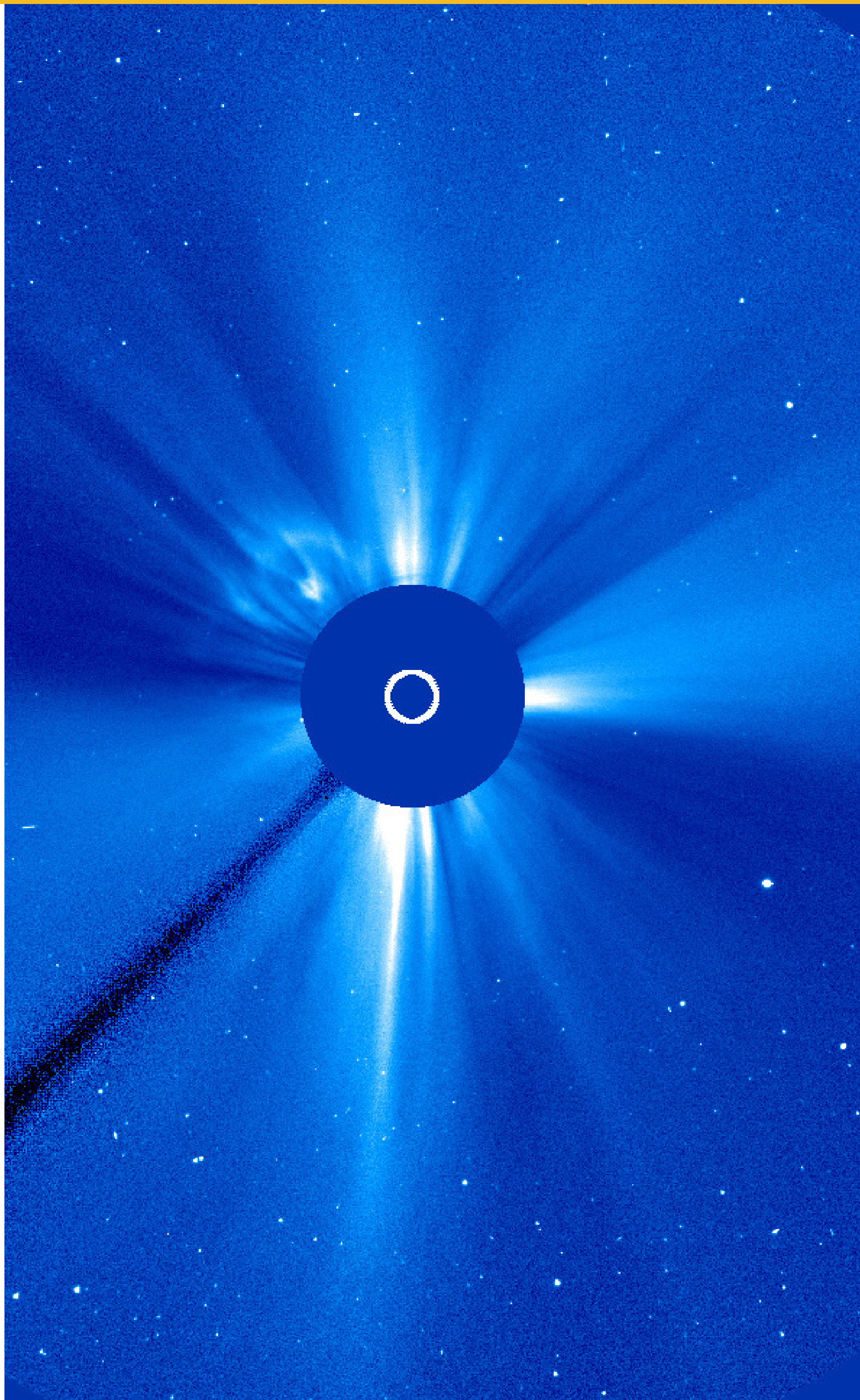
How does the Moon help us study the Sun?

Hakeem Oluseyi travels the world to find just the right locations to see total eclipses of the Sun. He's been to Asia and Africa to see total eclipses; he went to Texas in 2024. Total eclipses help him study the Sun's corona, its outer atmosphere. Because the Sun's disk is so bright, the corona is usually hidden. But when the disk is covered, the wispy corona shines in the darkness.

MAIN IDEA

Participants in this activity learn how the Moon's distance from the Sun and the viewer's position on Earth can create ideal conditions for observing the corona. They use Sun and Moon models to simulate total, annular, and partial solar eclipses.

RIGHT: Spaceborne coronagraphs mimic a total solar eclipse, enabling scientists like Hakeem Oluseyi to study the corona.



MATERIALS

TABLE SIGNS

- instruction sign (in sign holder)
- scientist connection sign (in sign holder)

ACTIVITY COMPONENTS

- UV-printed Sun on fabric
- metal stand for fabric Sun
- small Moons on acrylic
- 1 or 2 UV flashlights

OPTIONAL EXTENSION ACTIVITY:
Make-and-Take Sun and Moon Models

- 3-inch circle punch (for Suns' coronas)
- 2.5-inch circle punch (for Suns' disks)
- 1-inch circle punch (for Moons)
- black cardstock
- white cardstock
- orange cardstock
- coffee stir sticks (2 per participant)
- glue dots (4–6 per participant)

SAFETY NOTES

- While the UV flashlights use UVA wavelengths that are generally not considered to be as dangerous as other wavelengths, it is a good idea to follow some basic precautions.
    - » Never look directly into the UV flashlight.
    - » Do not shine the UV light directly on skin.
    - » Limit exposure to the UV light.
- Make sure that all components are in good condition prior to the activity. Replace worn, splintered, or frayed items.

PREPARATION

FOR ENGAGING A GROUP OF PARTICIPANTS IN A FACILITATED MAKERSPACE, SCIENCE CAMP, ENRICHMENT CLASS DURING A FIELD TRIP, OR SIMILAR SETTING:

- Designate a table as a "Discover the Sun's Atmosphere" activity station within the space you have designated for *Hidden No More*.
- Position the activity instruction and scientist connection signs on the activity table.
- Attach the fabric Sun model to its stand, and place the stand on the table. If the fabric model is in a busy area or likely to be knocked over, you may wish to attach

PREPARATION, continued

the base firmly to the table. See page 12 for more information about setting up the fabric Sun model.

- Place the small acrylic Moons and a UV flashlight on the table. See page 13 for more information about these components.

FOR ENGAGING INDIVIDUALS OR PAIRS AT A FACILITATED TABLE IN AN EXHIBIT AREA, MAKERSPACE, SCIENCE EXPO, OR SIMILAR SETTING:

- Prepare a "Discover the Sun's Atmosphere" activity table in the same way as you would set up a station for engaging a group of participants. (See above.)

FOR THE OPTIONAL MAKE-AND-TAKE SUN AND MOON MODELS:

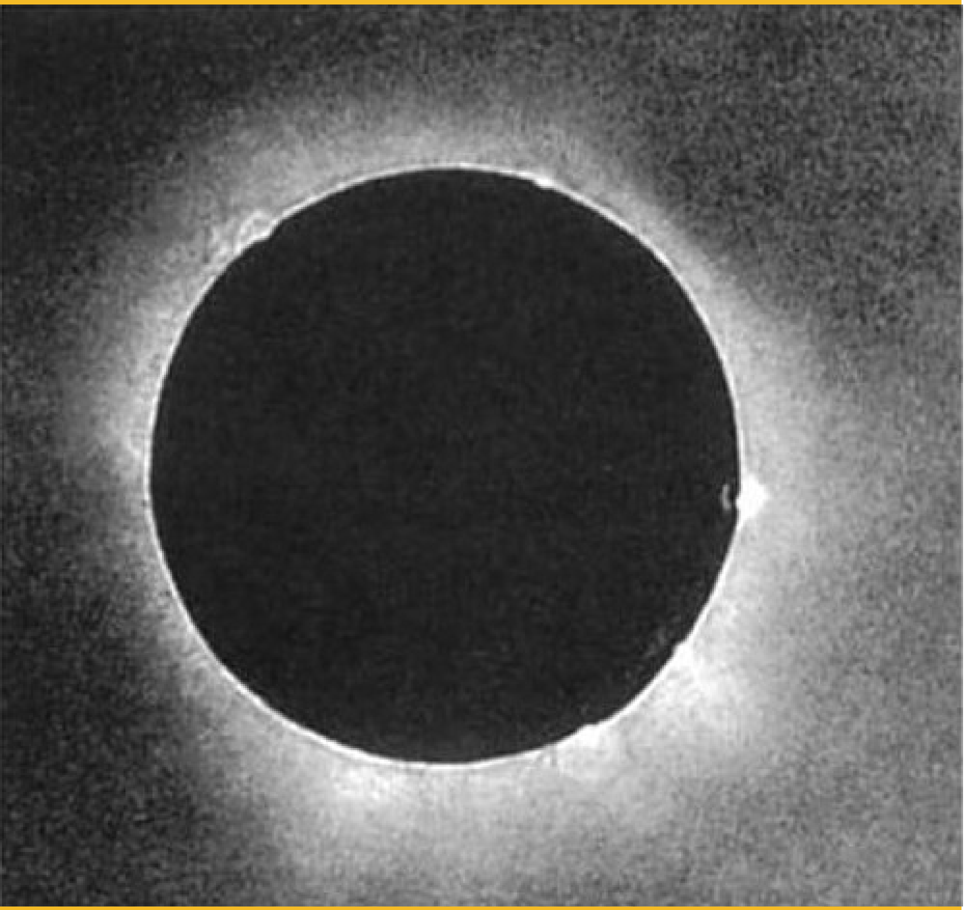
- Use the circle punches to pre-cut cardstock circles:
  - » 1-inch black circles for the Moon
  - » 2.5-inch orange circles for the Sun's disk
  - » 3-inch white circles for the Sun's corona

  See page 14 for more information about preparing these materials.

- Organize the coffee stir sticks (2 per participant) and glue dots (4–6 per participant). To make the glue dots easier to share among participants, cut the sheets of glue dots into sections of 4–6 dots each.

TRY THE ACTIVITY

1. Create a total eclipse.
   - » Move the Moon until it covers the main part of the Sun.
   - » The main part of the Sun is called the "disk." What part of the Sun can you see when the disk is covered?
   - » Point the ultraviolet (UV) light at the Sun to help you see the corona around the disk.
2. Create an annular eclipse.
   - » Keep the Sun and Moon aligned in front of you.
   - » Move the Moon forward or backward until only the edge of the Sun's disk—a thin "ring of fire"—is visible.
   - » The Moon isn't always the same distance from Earth. You see an annular eclipse when the Moon is farthest from Earth and appears smaller.
3. Create a partial eclipse.
   - » Keep the Sun and Moon aligned in front of you.
   - » Tilt your head and look at the Sun.
   - » You have to be in the right place to see a total eclipse! You see a partial eclipse when the Sun and Moon are not aligned in front of you.



ABOVE: The first successful photograph of a total solar eclipse and the Sun's corona, taken on July 28, 1851.

Photographer Johann Julius Friedrich Berkowski used the daguerreotype process to take this photograph of a total solar eclipse from his location in Prussia (now Russia). The corona shines around the outside of the covered disk.

TRY THE ACTIVITY, continued

4. Depending on the time available to carry out the optional extension activity, provide participants with materials to make their own Sun and Moon models to experiment with and take home.

GUIDING QUESTIONS

- When you move the Moon model, how does the distance between the Moon and the Sun affect your view of the Sun?
- Can the small Moon model eclipse other larger objects in the room? How about your hand, the "Meet the Scientists" banner, or a window?
- Would you be interested in studying the Sun as Dr. Oluseyi does? What would you like to find out?
- Have you ever seen a solar eclipse? What was it like? Would you be interested in traveling around the world to see a total eclipse, like Dr. Oluseyi does?

ABOUT THE SCIENCE

- Scientists study the corona—and government space agencies constantly monitor it—because it generates solar winds and other space weather events that can affect spacecraft, astronauts, and even communication systems here on Earth!

ABOUT THE SCIENCE, continued

- Scientists wonder why the corona, the outermost layer of the solar atmosphere, is so much hotter than the Sun's surface. Temperatures in the corona spike upward of 2 million degrees Fahrenheit. Just 1,000 miles below, the underlying surface of the Sun simmers at 10,000 F.
- The Sun is by far the strongest source of ultraviolet (UV) radiation in our environment. UV light has shorter wavelengths than visible light. Although UV waves are invisible to the human eye, some insects, such as bumblebees, can see them.

FACILITATION TIPS

- Review the "Safety Notes" included on page 6.
- Before facilitating this activity, experiment with the models yourself. This will help prepare you to answer questions and offer tips. (For example: tips about tilting one's head to the side or forward in order to observe partial eclipses with the models.)
- Be alert to participants who require assistance. At the same time, be careful not to "take over" the activity. Give additional information and offer help as needed, while allowing participants to do and discover as much as they can independently.

INNOVATE ON THE ACTIVITY

Include images of current space weather conditions gathered via coronagraphs in space.

Real-time images of activity in the Sun's corona are captured constantly by the Large Angle and Spectrometric Coronagraph (LASCO) instruments on board the SOHO (Solar and Heliospheric Observatory) spacecraft.

- » **Still images—https://soho.nascom.nasa.gov/data/realtime-images.html**
- » **Moving images at NOAA's Space Weather Prediction Center—https://www.swpc.noaa.gov/products/lasco-coronagraph**

As a graduate student at Stanford University, Dr. Oluseyi was on the team (led by his mentor Arthur B. C. Walker Jr.) that pioneered the technology that gives us images from SOHO and the Solar Dynamics Observatory spacecraft.

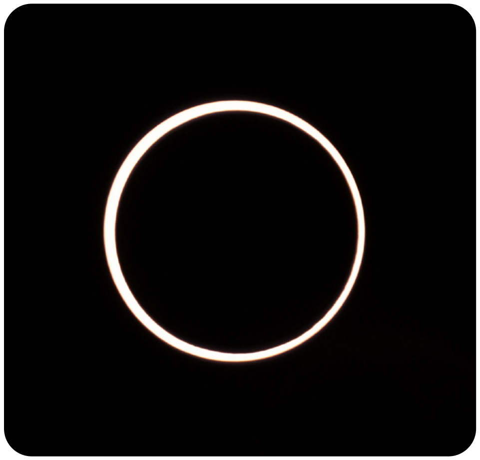
FACILITATION TIPS, continued

- If you are planning to include the make-and-take Sun and Moon models, practice applying glue dots. Participants who have not used glue dots before may need your advice. Offer this suggestion: Press the dot firmly onto the cardstock or stir stick, then rip the backing off quickly (a bit like a bandaid!).
- Participants may be curious about the dates of future eclipses. Before facilitating this activity, check NASA's *Future Eclipses* website to learn when there will be solar and lunar eclipses over the next several years, what type they will be, and where they can be best viewed: https://science.nasa.gov/eclipses/future-eclipses/. The next total solar eclipse will be on August 12, 2026.

MORE TO LEARN

ABOUT ANNULAR ECLIPSES

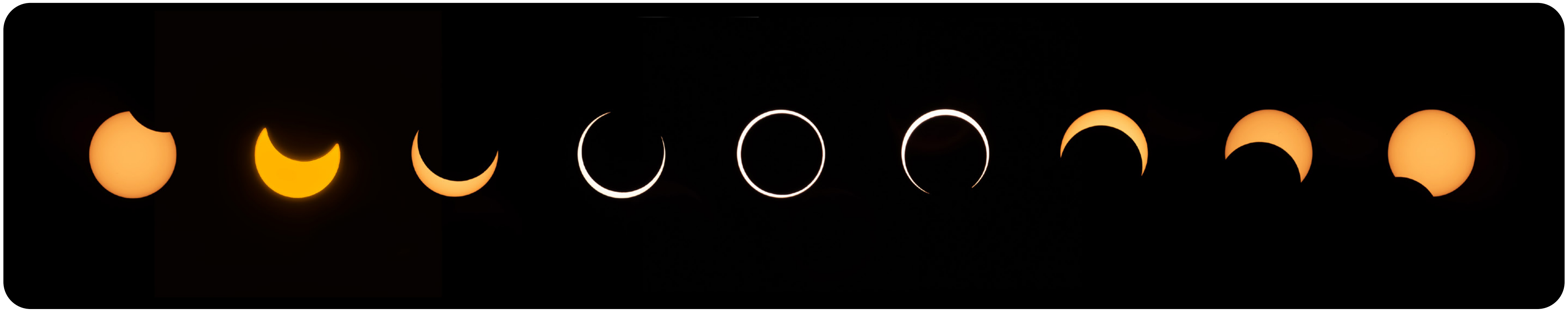
Participants in the "Discover the Sun's Atmosphere" activity use Sun and Moon models to simulate total, annular, and partial solar eclipses. The annular solar eclipse may be the most difficult to explain.

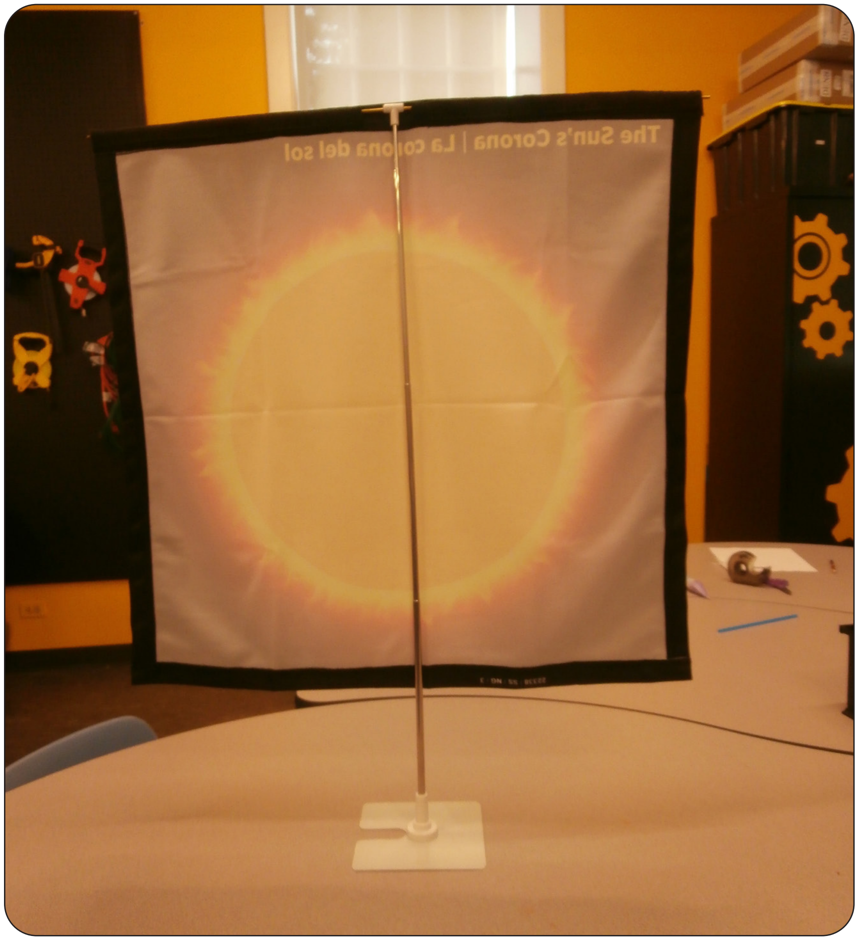


Because its orbit around Earth is slightly egg-shaped (rather than a perfect circle), the Moon is not always the same distance away from us. We see an annular eclipse when the Moon is farthest from Earth. At that time, the Moon appears smaller and does not completely cover the Sun's disk.

The word annulus refers to the ringlike area between concentric circles. The shape of a doughnut or washer (like the washers tested in the "Investigate Conductors and Insulators" activity) is an example of an annulus.

These photographs were taken during the annular solar eclipse on October 14, 2023. The photographer, Kim Moore, was located at Bears Ears National Monument, Utah. A special solar filter on the camera protected her eyesight.



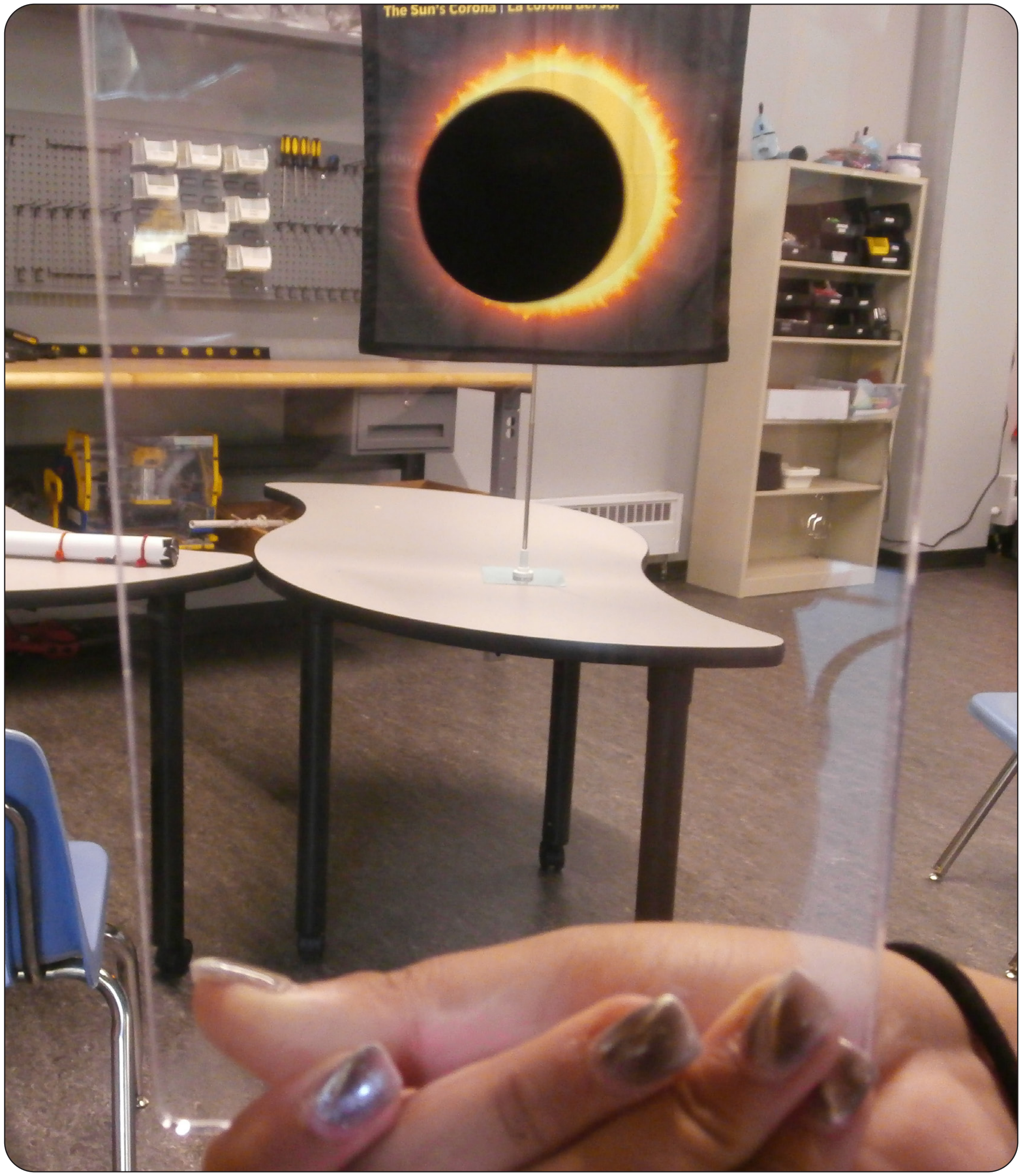


MODEL OF THE SUN'S CORONA

This fabric model has been printed with UV inks. The Sun will glow when the inks are activated by the UV flashlight. The fabric is lightweight and measures 24 inches x 24 inches.

Above: Back of the model. To attach the fabric to the stand, thread the horizontal metal rod through the felt channel on the back of the fabric and the plastic "T" joint at the top of the vertical pole.

The metal stand enables the model to be placed on a table. The vertical pole can be adjusted to about 37 inches in height.



USE SUN AND MOON MODELS TO SIMULATE ECLIPSES

The *Hidden No More* kit includes several small models of the Moon in the form of black circles on clear acrylic.

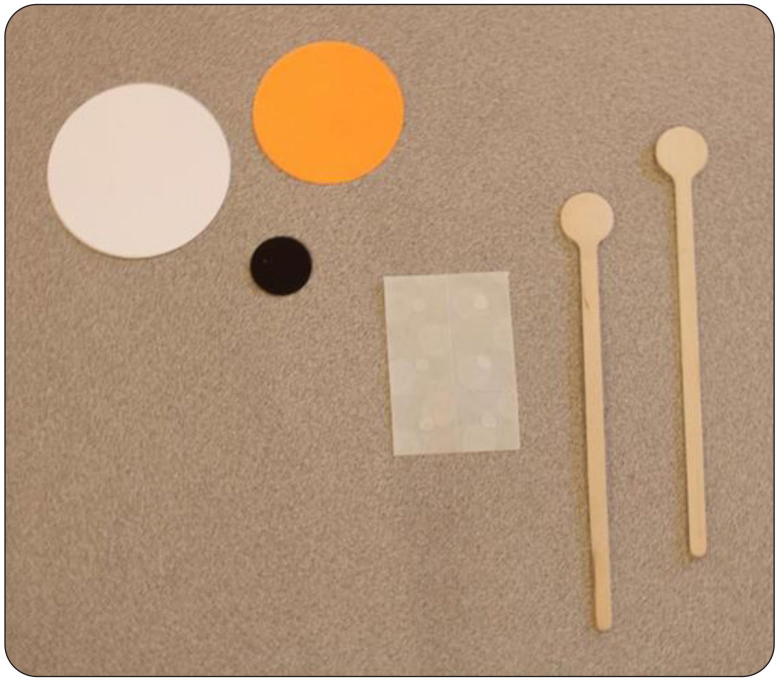
Invite participants to hold an acrylic Moon model and position it to block the main disk of the fabric Sun. By moving the acrylic Moon model back and forth, and side to side, participants can create total, annular, and partial eclipses.

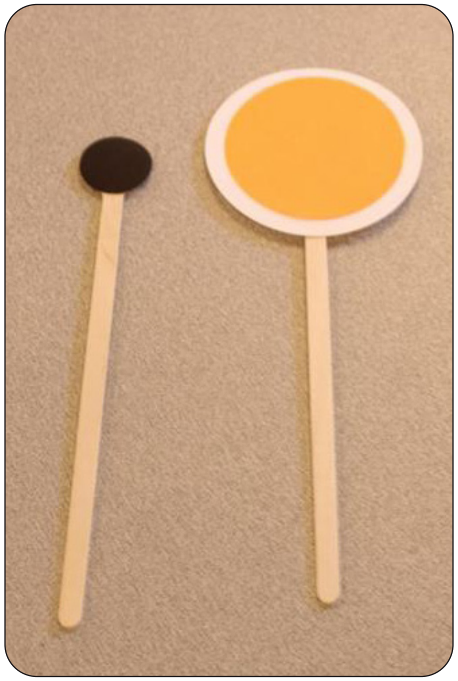
USE THE UV FLASHLIGHT

Assist participants by shining the UV flashlight on the Sun model so they can see the corona shining when they cover the Sun's main disk with the Moon.

USE THE MAKE-AND-TAKE MOON MODEL

If participants complete the "Eclipse Model to Make and Take" activity, they can also use their cardstock Moon model to eclipse the fabric Sun. The cardstock circles and the circles on the acrylic models are a similar size.





ECLIPSE MODEL TO MAKE AND TAKE

This model is made with cardstock circles, coffee stir sticks, and glue dots.

Use a 3-inch circle cutter to make a white circle.

Use a 2.5-inch circle cutter to make an orange circle.

Use a 1-inch circle cutter to make a black circle.

The *Hidden No More* kit includes cardstock, coffee stir sticks, and glue dots to make this model. The kit also includes three circle cutters in the sizes needed.

.

Above: The back of the Moon and Sun models.

Make the Moon: Use a glue dot to stick a black circle on the round end of a stir stick.

Make the Sun: Use 2 glue dots to stick an orange circle on a white circle. Use 2 glue dots to stick the white circle on the round end of another stir stick.

Above: The front of the Moon and Sun models.

Do your best to center the orange circle on the white circle.

The orange circle represents the Sun's central disk. The white circle represents the Sun's corona.

Investigate Invisible Light

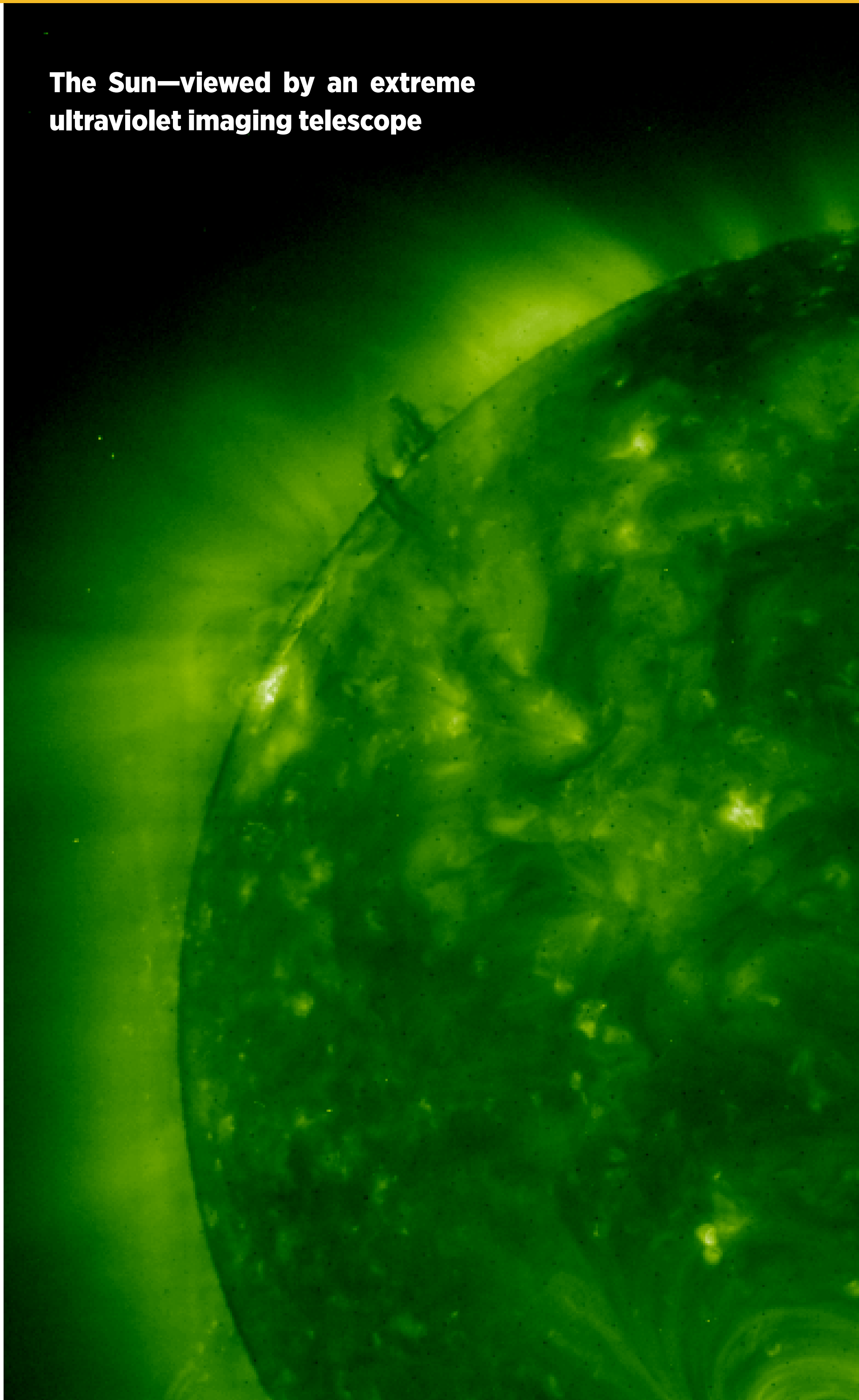
Can you detect a kind of invisible light that is all around you?

Hakeem Oluseyi helped pioneer technology that enables us to study the Sun in wavelengths of light beyond the visible spectrum. These wavelengths of light are electromagnetic radiation—energy—the human eye cannot see.

Infrared (IR) light is the focus of the "Investigate Invisible Light" activity, while ultraviolet (UV) light is used in the "Discover the Sun's Atmosphere" activity. Both IR and UV are just outside the range of light that is visible to the unaided human eye. They are invisible light.

MAIN IDEAS

Participants use an infrared camera to detect heat, leading to understanding about light waves beyond the visible spectrum. They also use the infrared camera to compare incandescent bulbs and LED (light-emitting diode) bulbs, demonstrating advances in light bulb technology.


The Sun—viewed by an extreme ultraviolet imaging telescope

MATERIALS

TABLE SIGNS

- instruction sign (in sign holder)
- scientist connection sign (in sign holder)

ACTIVITY COMPONENTS

- 2 large light bulb holders
- large LED light bulb
- large incandescent light bulb
- 1 or 2 rechargeable infrared cameras
- 1 or 2 black acrylic sheets
- 1 or 2 white acrylic sheets
- 1 or 2 clear insulator sheets

ALTERNATIVE SET-UP: Use these circuit supplies from the *Hidden No More* kit when an electrical outlet is unavailable:

- 2 battery holders with batteries
- 2 small light bulb holders
- 1 small incandescent light bulb
- 1 small LED light bulb
- 4 leads

SAFETY NOTES

- Use the infrared camera appropriately. Never point the infrared camera at another person without their permission.
- Unplug the light bulb holders before inserting the light bulbs.
- If no electrical outlet is available and the alternative set-up with circuit supplies is used, make sure that all batteries are removed from the battery holders at the end of the activity.
- Make sure that all components are in good condition prior to the activity. Replace worn, splintered, or frayed items.

PREPARATION

FOR ENGAGING A GROUP OF PARTICIPANTS IN A FACILITATED MAKERSPACE, SCIENCE CAMP, ENRICHMENT CLASS DURING A FIELD TRIP, OR SIMILAR SETTING:

- Designate a table as an “Investigate Invisible Light” activity station within the space you have designated for *Hidden No More*.
- Position the activity instruction and scientist connection signs on the activity table.
- Place two lamp bases on the activity table—one base

holding a large LED bulb, and the other holding a large incandescent bulb. See page 21 for more information about preparing these lamp bases.

- Charge the infrared cameras before the event. Place the cameras on the activity table.
- Depending on the space available, place one or more of the acrylic sheets on the table. If there is time for participants to experiment with comparisons, provide both black and white acrylic sheets.
- Place one or two clear insulators sheets at the table.
- If no electrical outlet is available, use circuit supplies to create two circuits. Include a small LED light bulb in one circuit, and a small incandescent light bulb in the other.

FOR ENGAGING INDIVIDUALS OR PAIRS AT A FACILITATED TABLE IN AN EXHIBIT AREA, MAKERSPACE, SCIENCE EXPO, OR SIMILAR SETTING:

- Prepare an "Investigate Invisible Light" activity table in the same way as you would set up a station for engaging a group of participants (described above).

TRY THE ACTIVITY

1. An infrared camera detects invisible light waves emitted by warm objects:
   » Point the camera at your hand to show the infrared light radiating from it.

   » Place a clear plastic shield over your hand. What does the infrared camera show now? What is happening?

   » Place your hand on the acrylic mat for five seconds. Lift your hand up and point the infrared camera at the acrylic. What do you notice?
2. *Note: The following experiment can take several minutes.* If there is a white mat and a black mat on the table, place one hand on each mat—at the same time—for five seconds.
   » Raise your hands and look at both mats in the camera's viewfinder. Is there a difference between the mats?

   » Keep watching. Does one handprint disappear more quickly than the other? *(It is likely that the handprint on the white mat will disappear more quickly, while the handprint on the dark mat lingers. Darker colors absorb more heat than do paler colors.)*

ABOVE: A planetary nebula as viewed by the James Webb Space Telescope's near-infrared camera (NIRCam). The nebula is an irregular oval shape, with reddish-orange plumes of gas and dust. In the center, two stars glow, one more brightly than the other.

Images captured by spaceborne infrared cameras help scientists like Hakeem Oluseyi study stars far beyond our own solar system.

TRY THE ACTIVITY, continued

3. Point the infrared camera at an incandescent light bulb, then at an LED (light-emitting diode) bulb. Which light bulb emits more energy in the form of heat?

GUIDING QUESTIONS

- When you placed a clear plastic shield over your hand, why could you see your hand but not detect the infrared light waves? (*You can observe your hand because visible light waves pass through the clear plastic and reach your eyes; at the same time, the plastic acts as an insulator so that heat in the infrared spectrum cannot be detected.)*
- Which type of light bulb on the table do you think was invented in the 1800s? *(The incandescent bulb.)*
  - » In his book, Lewis Latimer explained that incandescence refers to the "white heat" glowing from the electrified filament in the bulb.
- Which type of light bulb on the table do you think was invented in the 1960s? *(The LED, or light-emitting diode.)*
  - » The first practical visible-spectrum light-emitting diode was invented in 1962 by Nick Holonyak, Jr., at General Electric.
  - » General Electric was formed by the merger of Edison General Electric and Thomson-Houston in 1892. Latimer, who worked at Edison General Electric, thus became one of the first employees of General Electric.

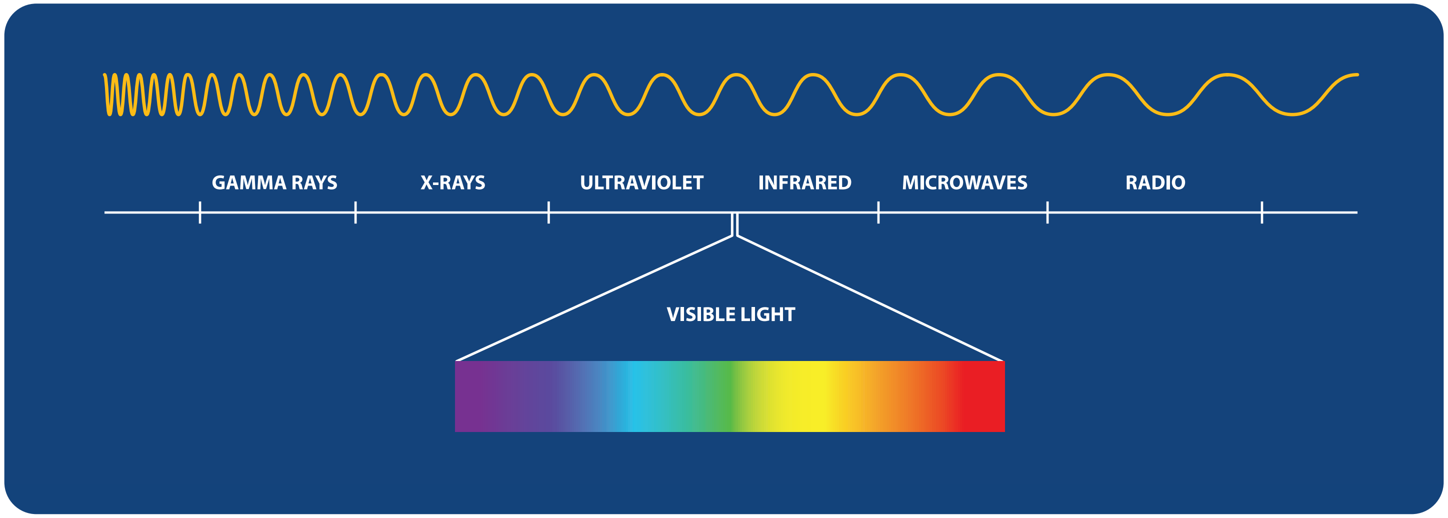
ABOUT THE SCIENCE

- Participants may ask, "If light is invisible, how can we see it?" Depending on the kind of invisible light, we can use a tool, like the infrared camera, to detect it. It's a bit like revealing hidden fingerprints by brushing them with fingerprint powder at a crime scene—or by breathing on a cold windowpane in winter!
- Light energy and heat (thermal) energy are different forms of kinetic energy.
  - » Kinetic energy is the motion of waves, electrons, atoms, molecules, substances, and objects.
  - » Light energy is a form of electromagnetic energy, also called electromagnetic radiation, emitted by warm or hot objects (like the Sun, light bulbs, and even people!).
  - » Light energy can be converted into heat energy through the process of absorption.
- Dark colors absorb more light energy than do light colors. We may notice this when we wear dark- or light-colored clothing on a sunny day:
  - » A dark-blue jacket absorbs more wavelengths of light, which it converts to heat energy. The wearer of this jacket feels uncomfortably warm.
  - » Meanwhile, a pale-yellow jacket reflects more wavelengths of light, so it absorbs less light energy that can be converted to heat energy. The wearer of this jacket feels comfortably cool!

FACILITATION TIPS

- Review the "Safety Notes" included on page 16.
- Before facilitating this activity, experiment with the infrared camera yourself. This can be particularly helpful as you assist participants using this type of camera for the first time.
- Suggest that participants view other electric lights in the room through the infrared camera.
- Be alert to participants who require assistance. At the same time, be careful not to "take over" the activity. Give additional information and offer help as needed, while allowing participants to do and discover as much as they can independently.

MORE TO LEARN
ABOUT THE ELECTROMAGNETIC SPECTRUM



Visible light comes to the human eye as colors ranging from deep red to deep violet.

Light also comes in the form of radio waves, microwaves, infrared light, ultraviolet light, X-rays, and gamma rays. These represent light the human eye cannot see—invisible light.

We call this continuous range of light the electromagnetic spectrum.

Light is often called electromagnetic radiation because it has electric and magnetic properties.

Light is made of photons (tiny packets of energy).

Every form of light is associated with a wavelength and an energy. Energy, in turn, is associated with temperature.

USE AN INFRARED CAMERA TO COMPARE THE ENERGY OUTPUT OF LED AND INCANDESCENT BULBS

The *Hidden No More* kit includes two lamp bases, LED and incandescent bulbs, and a rechargeable infrared camera. The lamp bases require access to an electrical outlet that can accommodate two plugs.

Top: Unplug the lamp bases. Screw each type of bulb into the lamp bases. Plug the lamp bases into the outlet. An ON/OFF switch is located on each cord.

Bottom: The two light bulbs as they appear in the viewfinder of the infrared camera. The LED bulb is on the left; the incandescent bulb is on the right.

For an alternative set-up that does not require an electrical outlet, use circuitry supplies from the *Hidden No More* kit. These supplies are listed on page 32.

Remember to charge the infrared cameras before your event.

Explore Conductors and Insulators

Which materials let electricity flow?

Lewis Latimer's book *Incandescent Electric Lighting* was published in 1890. He wrote that, less than 10 years before, incandescent electric light "had barely got beyond the stage of a laboratory experiment."

Lewis Latimer wanted people to be informed about electric lighting, which was increasingly being used in businesses and homes. So, he taught his readers how electrical energy is generated and supplied to a city. He told them how energy flows through a circuit to make a light bulb glow at home. He discussed switches, conductors, and insulators.

This hands-on making activity explores conductors and insulators—materials that were fundamental to Lewis Latimer's work in the early electric light industry.

RIGHT: Illustrations from the organizing mat included in the Hidden No More kit.

MAIN IDEAS

Participants use an electrical circuit to test different materials, discovering that some are conductors (let electricity flow to the light bulb), while other are insulators (prevent electricity from flowing to the light bulb).

Participants may also consider which of the materials they are testing were invented in Lewis Latimer's lifetime, reinforcing a *Hidden No More* theme of invention.

MATERIALS

TABLE SIGNS

- Activity instruction sign (with sign holder)
- Scientist connection sign (with sign holder)

BASIC CIRCUITRY SUPPLIES

- battery holders with batteries
- small light bulb holders
- small LED light bulbs
- leads (with alligator clips modified for accessibility)

MATERIALS TO TEST

- aluminum foil strips
- bamboo pieces
- cardstock, small pieces (2-inch x 3-inch pieces of cardstock are included in the *Hidden No More* kit)
- copper washers
- paper clips
- pencils (6H)
- pencils (HB, two-sided)
- pencil sharpeners
- pipe cleaners
- rubber bands
- stainless steel washers
- vinyl strips

Note: At the end of the activity, retrieve materials that can be reused.

ORGANIZING MAT

See page 25 for tips about using this mat.

SAFETY NOTES

- Make sure that all batteries are removed from the battery holders at the end of the activity.
- Make sure that all components are in good condition prior to the activity. Replace worn, splintered, or frayed items.
- Check all battery holders and motors for frayed wiring, loose springs, etc., prior to use.
- Check alligator clips for sharp edges or wires that may have come loose.

SAFETY NOTES, continued

- Make sure participants create connections with the alligator clips and not by twisting wires.
- Wires, pipe cleaners, and LEDs can have pointed ends that poke small hands. Caution participants to be careful.
- Motors can spin rapidly. Avoid getting motors near hair or loose clothing (ties, ribbons, laces).

PREPARATION

FOR ENGAGING A GROUP OF PARTICIPANTS IN A FACILITATED MAKERSPACE, SCIENCE CAMP, ENRICHMENT CLASS DURING A FIELD TRIP, OR SIMILAR SETTING:

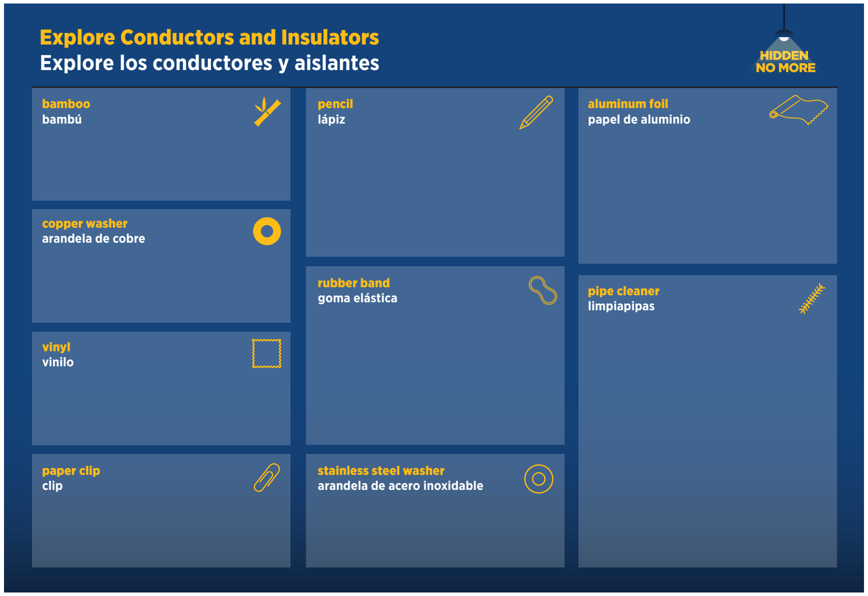
- Plan to divide the group into small teams. The *Hidden No More* kit includes materials for up to 30 participants divided into 10 teams of three. You can also invite participants to work individually if the group is small.
- Prepare these circuit supplies for each team: battery holder with batteries, small light bulb holder with small LED bulb, set of materials to be tested (rubber band, paper clip, etc.), and three leads.
- Use the “Explore Conductors and Insulators“ instruction and scientist connection signs to mark where in the space participants will be working on this activity. For instance, the signs can be placed on a central table where participants will collecting their supplies.
- As needed, move the table signs to different tables during the activity to be sure all participants have a chance to read or re-read the instructions and information about the scientists.

FOR ENGAGING INDIVIDUALS OR PAIRS AT A FACILITATED TABLE IN AN EXHIBIT AREA, MAKERSPACE, SCIENCE EXPO, OR SIMILAR SETTING:

- Position the “Explore Conductors and Insulators” instruction and scientist connection signs on the activity table.
- Place the organizing mat on the table. See page 25 for tips about using this mat to organize nine types of materials that participants can test.
- Near the organizing mat, place two 6H pencils and several pieces of cardstock.
- Also place two sets of circuit-building materials near the organizing mat. Each set will include: battery holder with batteries, small light bulb holder with small LED bulb, and three leads.
- Adjust the number of sets of circuit-building materials based on the number of facilitators and table size.

MORE TO LEARN
ABOUT THE ORGANIZING MAT

This 13-inch x 19-inch mat organizes nine types of materials that can be tested in the "Explore Conductors and Insulators" activity. Place the mat on a table in a facilitated area of an exhibit, science expo, or similar informal STEM learning setting.



Place two sets of circuit materials near the mat, making sure there is space on the table for participants to build circuits. Each set of circuit materials will include a battery holder with batteries, a small light bulb holder with a small LED light bulb, and three leads.

The mat shows the name for each item. The names help the facilitator to engage participants in a discussion about when the items may have been invented. Information about these inventions is included on page 27.

MATERIALS TO TEST

Place each type of material in the corresponding labeled space on the mat.

- 2 aluminum foil strips
- 2 bamboo pieces
- 2 copper washers
- 2 paper clips
- 2 pipe cleaners
- 2 rubber bands
- 2 stainless steel washers
- 2 vinyl strips
- 2 pencils (HB, two-sided)

Limiting the amount of materials to two of each type will reduce clutter on the table and enable participants to grasp each item more easily. Retrieve items after testing and return them to the mat for the next participants to use.

ADDITIONAL MATERIAL TO TEST:
GRAPHITE ON CARDSTOCK

Place two 6H pencils and several pieces of cardstock near the mat. Participants can use these to create and test graphite lines. See page 30 for more tips on testing graphite lines.

TRY THE ACTIVITY

1. You can work by yourself or in a team.
2. You'll need a small LED light bulb in a bulb holder, three leads, and a battery holder. (The light bulb is the load—the part of the circuit that uses electrical energy. The batteries are the source of the electrical energy.)
3. Put one lead aside. Use the other two leads to build a circuit that will power your light bulb.
4. Now you're ready to experiment!
5. Look at the different materials you can test (aluminum foil, bamboo, etc.) and predict which materials can be added to your circuit and still allow electricity to flow to the light bulb.
   - » Materials that allow electricity to flow are called "conductors."
   - » Materials that stop or slow the flow of electricity are called "insulators."
6. Add the third lead to your circuit. Then test your predictions by adding each type of material—one type at a time—to your circuit.

GUIDING QUESTIONS

- Does adding a lead and a conductor to your circuit affect the brightness of the LED?
- What else did you discover? Did any of the conductors or insulators surprise you?
- How did you make your predictions? Did you already know some things that helped you?
  - » Participants' answers might include: *I've noticed that appliances at home have electric wires that are covered with vinyl/plastic/rubber. Wires are made of metal, and people are warned not to touch electric wires after storms.*
  - » If participants have carried out a similar activity previously, ask if they tested some different materials then. Did they test some different materials this time?
- What do the conductors you tested appear to have in common?
  - » Participants might answer that most of the conductors they tested are metallic. Note that there are things other than metal that can conduct electricity: water, for example, and graphite (a form of carbon that is in the pencils they tested).

PROMPT A DISCUSSION

ABOUT INVENTIONS WE USE TODAY

- **"The electric light as a factor in our civilization is becoming daily of more importance." Lewis Latimer's 1890 statement is highlighted on a table sign. Was he correct? How many times a day do you use electric light? What about today? *(Some answers could include: stoplights, car lights, lights in the classroom or exhibit space, the video monitor.)***
- **Hakeem Oluseyi has been awarded patents for his inventions related to the manufacture of certain kinds of semi-conductors. Semi-conductors are used in many modern electronic devices. Can you spot an electronic device in the *Hidden No More* exhibit that has a semiconductor inside? *(Some answers could include: LED light bulbs, VR headsets, video monitor, infrared camera.)***

GUIDING QUESTIONS, continued

- Lewis Latimer lived from 1848 to 1928. Look at the materials you tested. Which do you think were invented in his lifetime? These are key dates for patents or other important steps related to their invention:
  - » Yes: aluminum foil (1910), paper clip (~1900); pipe cleaner (early 1900s); stainless steel (1913); vinyl (PVC, or vinyl, 1872; first synthetic plastic, 1907)
  - » No: modern graphite pencils (1795); rubber band (~1845)
  - » No: bamboo is a type of grass; copper is a metallic element on the Periodic Table of Elements

ABOUT THE SCIENCE

- Certain substances make better circuits than others. Some substances allow electrons to flow freely and are called conductors. Other substances stop the flow of electrons and are called insulators. An electron is a subatomic particle with a negative electrical charge.
- Participants in this activity discover that pencil leads, which are made of graphite (not lead!), can conduct electricity. Graphite occurs in nature. It is a form of carbon, an element on the Periodic Table of Elements.
- In his 1890 book about incandescent electric lighting,

ABOUT THE SCIENCE, continued

Latimer describes a light-bulb filament made of carbonized bamboo. In his time, scientists were trying to discover which materials made the most effective filaments for light bulbs. Bamboo was one of the materials they tried. Latimer also notes that copper is an excellent conductor of electricity.

FACILITATION TIPS

- Review the “Safety Notes” included on pages 23–24.
- Encourage participants to think of themselves as experimenters and inventors, like Lewis Latimer and Hakeem Oluseyi.
- Be alert to participants who require assistance as they explore the conductors and insulators provided. At the same time, be careful not to “take over” the activity. Provide additional information and help as needed, while allowing participants to do and discover as much as they can independently.
- Before facilitating this activity, experiment with it yourself. This can help you anticipate participants’ questions and recommend ways for them to problem-solve.

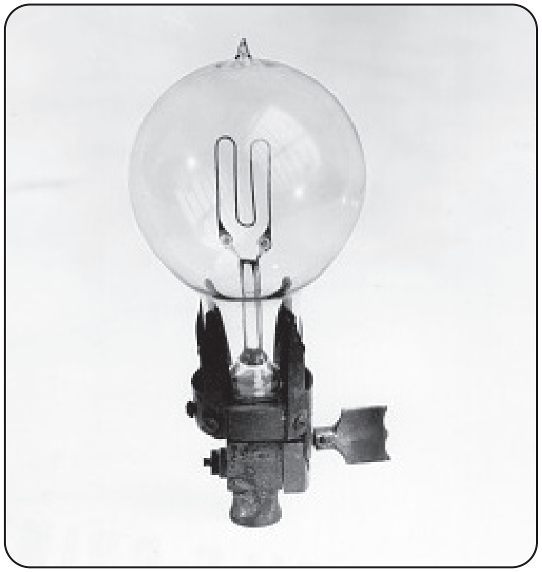
INNOVATE ON THE ACTIVITY

Add additional testing materials that will interest your visitors. For example, provide U.S. pennies (made of zinc coated with copper) and nickels (made of a copper-nickel alloy) and even low-denomination coins from other countries.

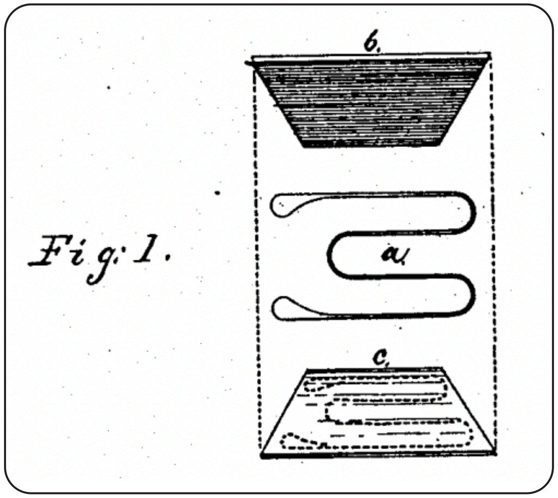
MORE TO LEARN

ABOUT LEWIS LATIMER'S PATENT FOR MAKING CARBON FILAMENTS

The "Explore Conductors and Insulators" activity includes testing pencil leads made of graphite, a form of carbon. Because carbon is a good conductor of electricity, early inventors of electric light bulbs, like Lewis Latimer, investigated ways to carbonize (by a process of heating) materials that could be made into filaments. Bamboo and cardboard were some of the materials they experimented with.



Above: Maxim carbon lamp made in about 1882. Light bulbs for Hiram Maxim's United States Electric Lighting Company had filaments with a distinctive "M" shape.

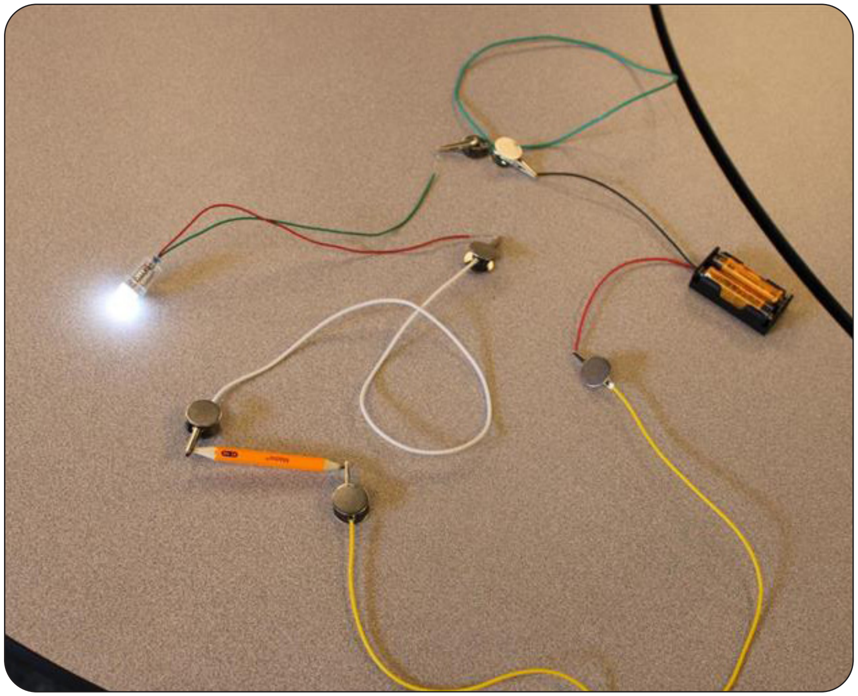


Above: Patent drawing for Lewis Latimer's "Process of Manufacturing Carbons" for electric light bulbs, which was patented on January 17, 1882.

Latimer received a patent for his "Process of Manufacturing Carbons" (1882), an improved method of turning carbonizable materials into filaments. He explained in his patent application, "My invention relates more particularly to carbonizing the conductors for incandescent lamps."

Ownership of Latimer's patent was assigned to his employer at the time, Hiram Maxim's United States Electric Lighting Company.

Filaments are delicate threads. Inside an airless light bulb, carbonized filaments glow (become incandescent) when they are heated by electricity.

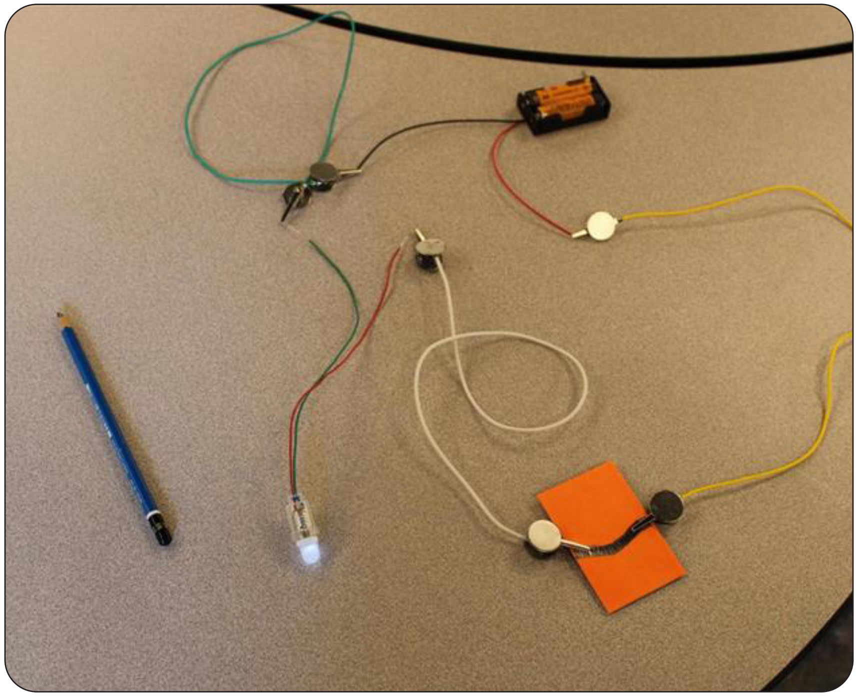


TESTING GRAPHITE: TWO-SIDED PENCIL

Short two-sided pencils are among the items participants can test for conductivity. The wooden part of the pencil is an insulator. But the pencil “lead”—which is actually graphite—is a conductor. Participants can test this by clipping leads to the ends of the pencil and adding it to their circuit.

The *Hidden No More* kit includes two-sided 2HB pencils and pencil sharpeners (in case the points break).

Notations such as 2HB, 6B, etc., relate to graphite grading scales. These scales indicate how hard (H) the pencil core is or how black (B) the pencils’ marks will be.



TESTING GRAPHITE: LINE DRAWN WITH A PENCIL

Invite participants to use an H6 pencil to draw a line on a piece of cardstock. They then clip leads to the ends of the drawn line to add the line to their circuit.

While the graphite line conducts electricity, the effect tends to be weak and the light emitted from the bulb is dim. Participants can experiment with different types of lines—straight and wavy, short and long.

The *Hidden No More* kit includes 6B pencils, cardstock, and pencil sharpeners. 6B pencils are soft, so participants can draw a thick line of graphite to test.

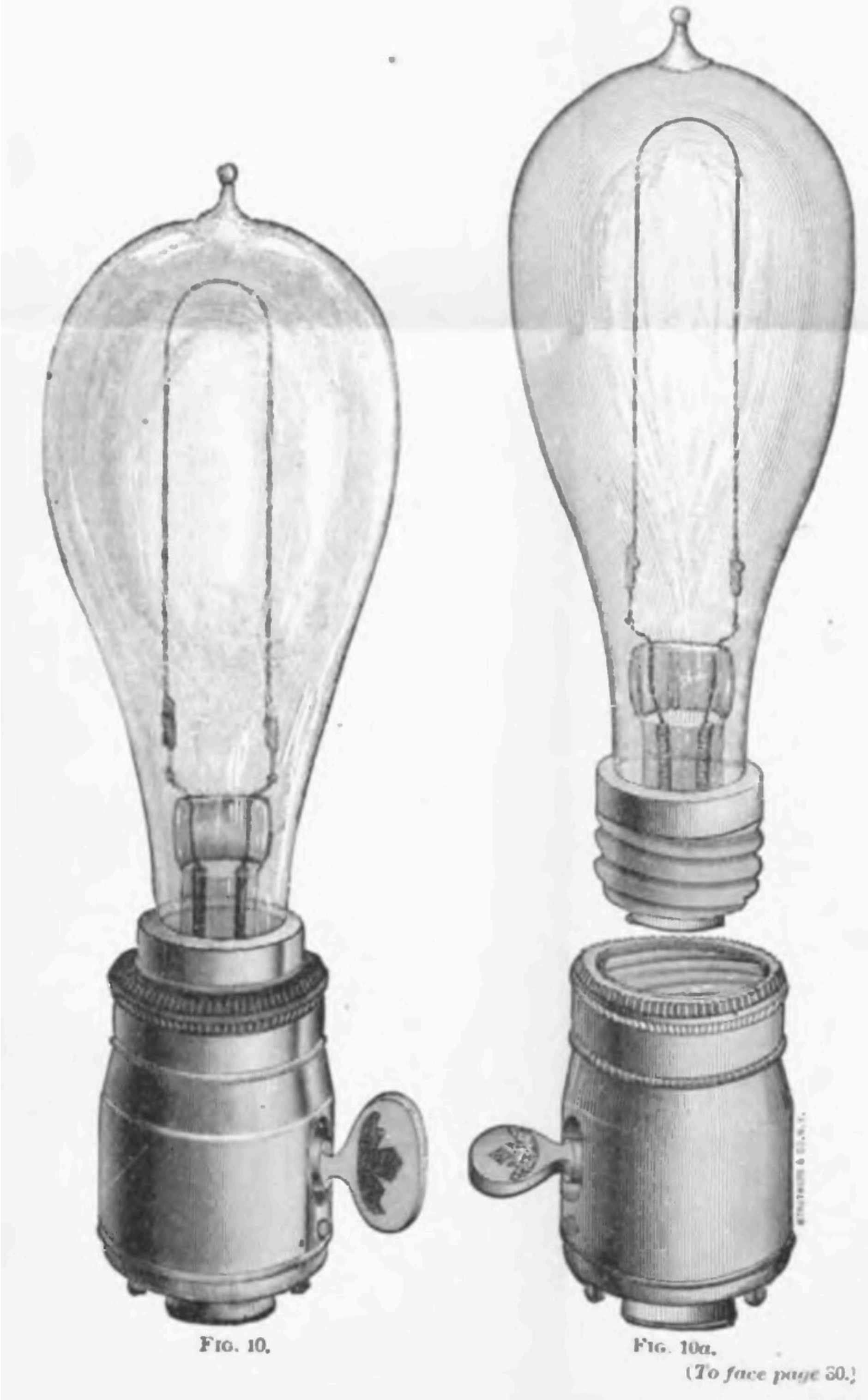
Invent a Switch

Can you invent a device to turn electricity on and off?

This hands-on making activity invites participants to follow the examples of Lewis Latimer and Hakeem Oluseyi, both of whom are notable for their inventions. Participants become inventors who are tasked with creating a switch that can turn electricity on—and make an LED light up, a buzzer buzz, or a propeller or color wheel spin.

RIGHT: In his book on incandescent electric lighting, Lewis Latimer explained the switches illustrated in these figures:

> "By rotating this key, shown projecting from the socket, the connection between this latter wire and the button of the socket can be either made or broken, thus enabling the lamp to be turned on and off at will."
>
> Lewis Latimer, 1890



MAIN IDEA

Participants use their knowledge of conductors and insulators to select materials and design a switch that will function in an electrical circuit.

MATERIALS

TABLE SIGNS

- activity instruction sign (with sign holder)
- scientist connection sign (with sign holder)

BASIC CIRCUITRY SUPPLIES

- battery holders with batteries
- buzzers
- motors
- propellers
- small LED light bulbs
- small light bulb holders
- leads (with alligator clips modified for accessibility)

MATERIALS FOR MAKING

- aluminum foil
- brads
- cardstock, small pieces (2-inch x 3-inch pieces of cardstock are included in the *Hidden No More* kit)
- copper washers
- Maker Tape
- paper clips, jumbo
- pencils (HB, two-sided)
- pipe cleaners, short
- rubber bands, assorted
- safety scissors
- tape, single-sided
- stainless steel washers
- waxed cord
- 1-hole punches

Note: At the end of the activity, retrieve materials that can be reused.

OPTIONAL MATERIALS

This activity provides an opportunity to use your organization's surplus crafting materials, such as Popsicle sticks or paper straws. Add materials that will interest participants, while taking care not to overwhelm them with too many choices.

OPTIONAL EXTENSION ACTIVITY:
DISAPPEARING COLOR WHEEL

- pre-printed blank wheels to color
- safety scissors
- assorted colored pencils
- pencil sharpeners

SAFETY NOTES

- Make sure that all batteries are removed from the battery holders at the end of the activity.
- Make sure that all components are in good condition prior to the activity. Replace worn, splintered, or frayed items.
- Check all battery holders and motors for frayed wiring, loose springs, etc., prior to use.
- Check alligator clips for sharp edges or wires that may have come loose.
- Make sure participants create connections with the alligator clips and not by twisting wires.
- Take care—wires, small LEDs, and pipe cleaners can have pointed ends that poke small hands.
- Motors can spin rapidly. Avoid getting motors near hair or loose clothing (ties, ribbons, laces).

PREPARATION

FOR ENGAGING A GROUP OF PARTICIPANTS IN A FACILITATED MAKERSPACE, SCIENCE CAMP, ENRICHMENT CLASS DURING A FIELD TRIP, OR SIMILAR SETTING:

- Plan to divide the group into small teams. The *Hidden No More* kit includes materials for up to 30 participants divided into 10 teams of three. You can also allow participants to work individually if the group is small.
- Prepare these circuit supplies for each team: battery holder with batteries, small light bulb holder with small LED bulb, set of materials to be tested (rubber band, paper clip, etc.), and three leads.
- Place the materials for making switches on a central table for easy access.
- Use the "Invent a Switch" instruction and scientist connection signs to mark where in the space participants will be working on this activity. For instance, the signs can be placed on the central table where participants will collect their supplies.
- As needed, move the table signs to different tables during the activity to be sure all participants have a chance to read or re-read the instructions and information about the scientists.

FOR ENGAGING INDIVIDUALS OR PAIRS AT A FACILITATED TABLE IN AN EXHIBIT AREA, MAKERSPACE, SCIENCE EXPO, OR SIMILAR SETTING:

- Position the "Invent a Switch" instruction and scientist connection signs on the activity table.
- Place a selection of materials for making switches on the table. As needed, tidy and replenish the supply of materials throughout the event.

INNOVATE ON THE ACTIVITY

- **Invite participants to add a disappearing color wheel to their motor.** ***(See page 37.)***
- **Increase the challenge:**
    - » **Design a switch that includes at least one type of material invented in Lewis Latimer's lifetime.**
    - » **Design a switch. Without showing them the completed switch, teach someone else (or another group) how to construct your design. Then change places and construct the other person's design.**
- **Provide additional materials to enable participants to create a chain-reaction switch or Rube Goldberg Machine. Based on the time and materials available, designate a number of steps each switch should take to make the connection.**

PREPARATION, continued

- Place two sets of circuit-building materials on the table. Each set will include: battery holder with batteries, small light bulb holder with small LED light bulb, and three leads.
- Adjust the number of sets of circuit-building materials based on the number of facilitators and table size.

TRY THE ACTIVITY

1. You can work by yourself or in a team.
2. Build a circuit to power a light bulb, buzzer, or motor.
3. Now try adding a switch that can stop or start the flow of electricity through the circuit. *(An example is shown on page 36.)*
    - » Use the materials on the table to design and build your switch.
    - » Your switch should include a conductor—a material that electricity can easily flow through.
4. Add your switch to the circuit. Does it work as you planned?
5. *As time and materials allow, invite participants to redesign their switches, or even try new designs.* Can your switch be improved? Adjust your design—or try a totally different approach—and test your new idea.

GUIDING QUESTIONS

- Are there some different ways to use your materials? For example:
  - » a pipe cleaner can be coiled into a spring, bent into a hook or latch, or used as an axle.
  - » a washer can become a weight, a wheel, or part of a pendulum.
  - » a piece of cardstock can be folded into a flap or door, folded like an accordion and act as a spring, or hole punched and threaded with string.
- Does adding a lead and a switch to your circuit affect the LED's brightness, the buzzer's loudness, or the motor's speed?
- *If participants are given the challenge to teach someone else to make their design:* Was it difficult or easy to teach someone else about your ideas? What was the most difficult part of your design to explain? What would you do differently, in terms of either your design or the way you explained your design?

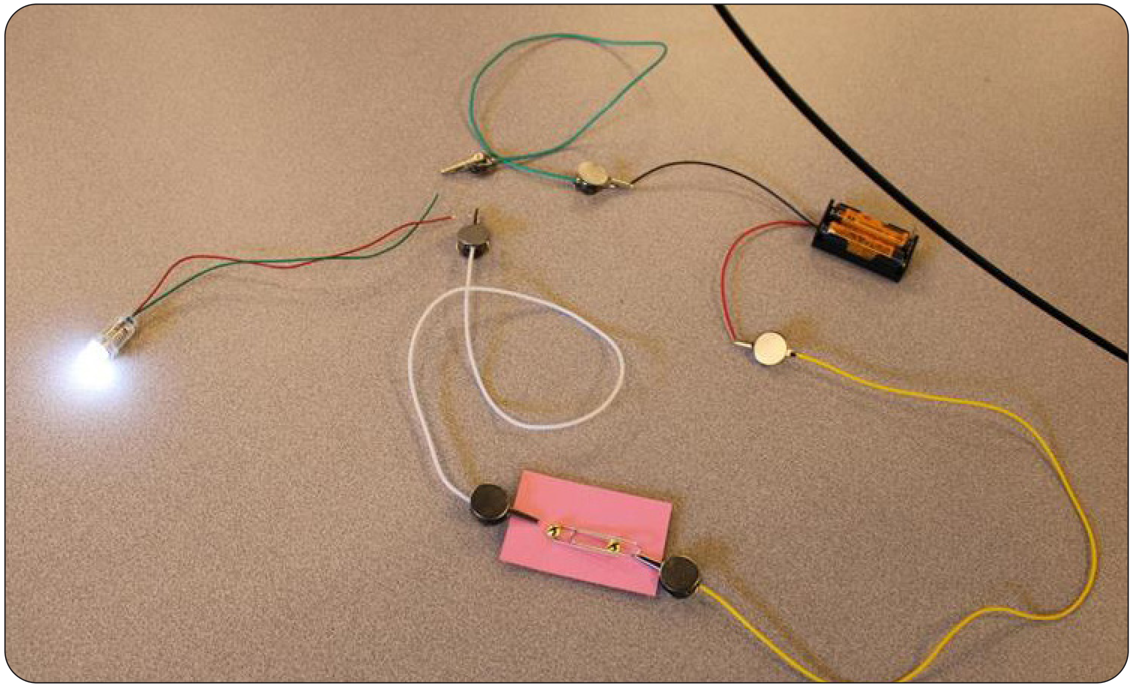
FACILITATION TIPS

- Review the "Safety Notes" included here.
- Encourage participants to think of themselves as experimenters and inventors, like Lewis Latimer and Hakeem Oluseyi.
- Be alert to participants who require assistance as they design and build their switches. At the same time, be careful not to "take over" the activity. Provide additional information and help as needed, while allowing participants to do and discover as much as they can independently.
- Before facilitating this activity, experiment with it yourself. This can help you anticipate participants' questions and recommend ways for them to brainstorm or troubleshoot their designs.

MAKE CONNECTIONS

TO OTHER EXHIBIT RESOURCES

In the documentary video included in this exhibit, Hakeem Oluseyi discusses how scientists can study light by breaking it down into its spectrum. This can be related to the disappearing color wheel included in "Invent a Switch." As the wheel spins, different colors of visible light "mix" and produce the appearance of the color white (see page 37). Other parts of the electromagnetic spectrum are explored in the "Investigate Invisible Light" activity.

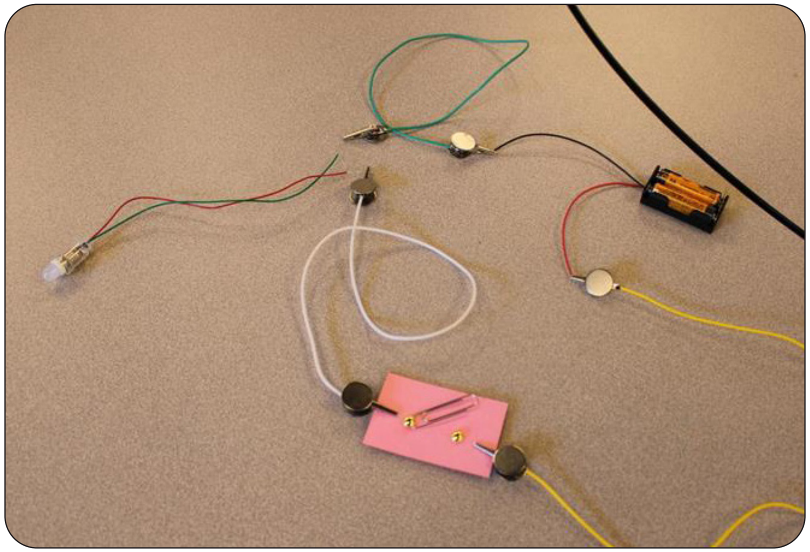


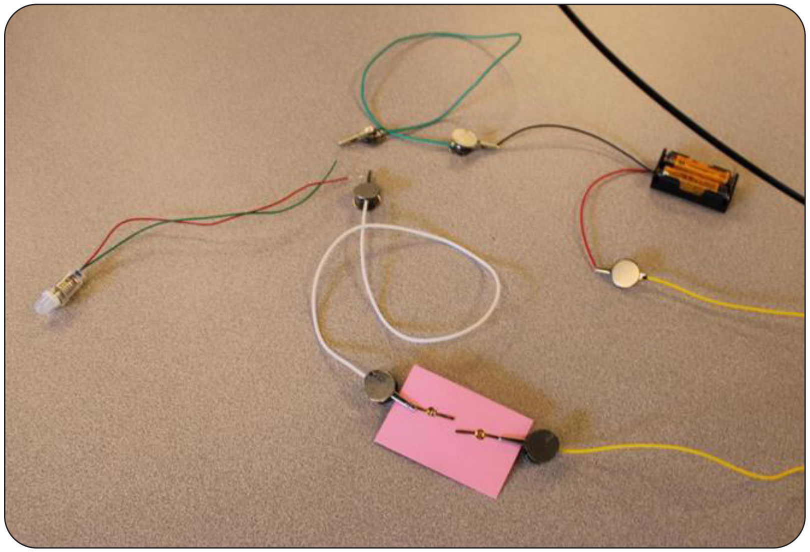
EXAMPLE SWITCH: This switch was made with a piece of cardstock, a large metal paperclip, and two metal brads. A hole punch was used to make holes in the cardstock for the brads to pass through.

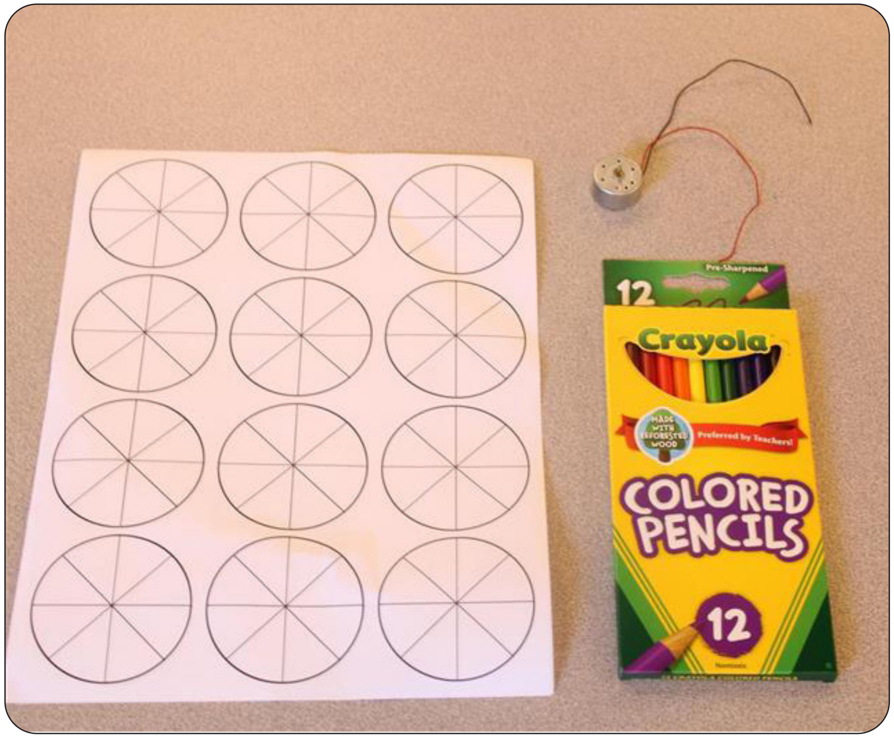
Top: The paperclip has been lowered so that it touches both brads. This action closes, or completes, the circuit and turns the light on.

Bottom left: Raising the paperclip turns the light off.

Bottom right: Back of the switch. Notice that the leads are clipped onto the brads to create a circuit.





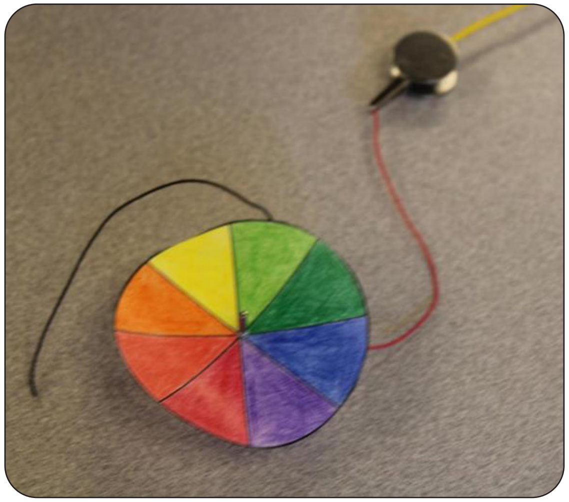


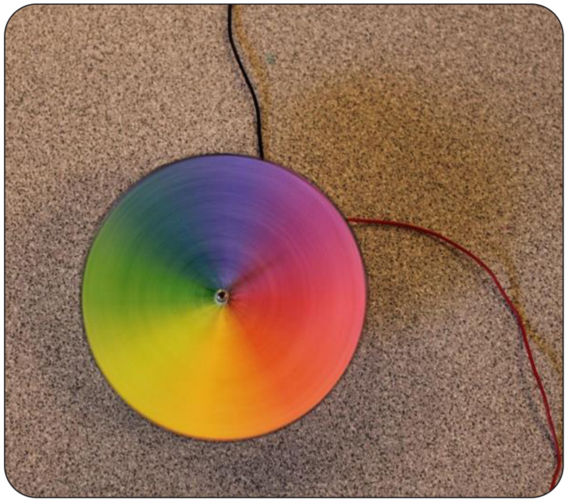
DISAPPEARING COLOR WHEEL: Invite participants to add a color wheel to the top of the motor in their circuit. Participants can choose to use a sequence of colors like a rainbow or they can experiment with other combinations of colors to see their results.

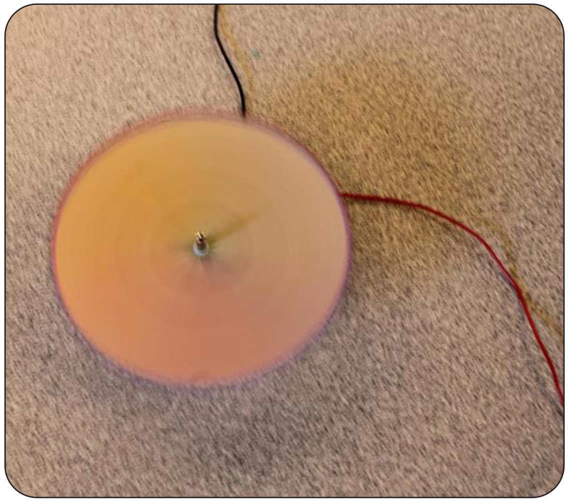
Top: The *Hidden No More* kit includes scissors, colored pencils, and a template for the paper color wheel. Motors are located in the circuitry supply box.

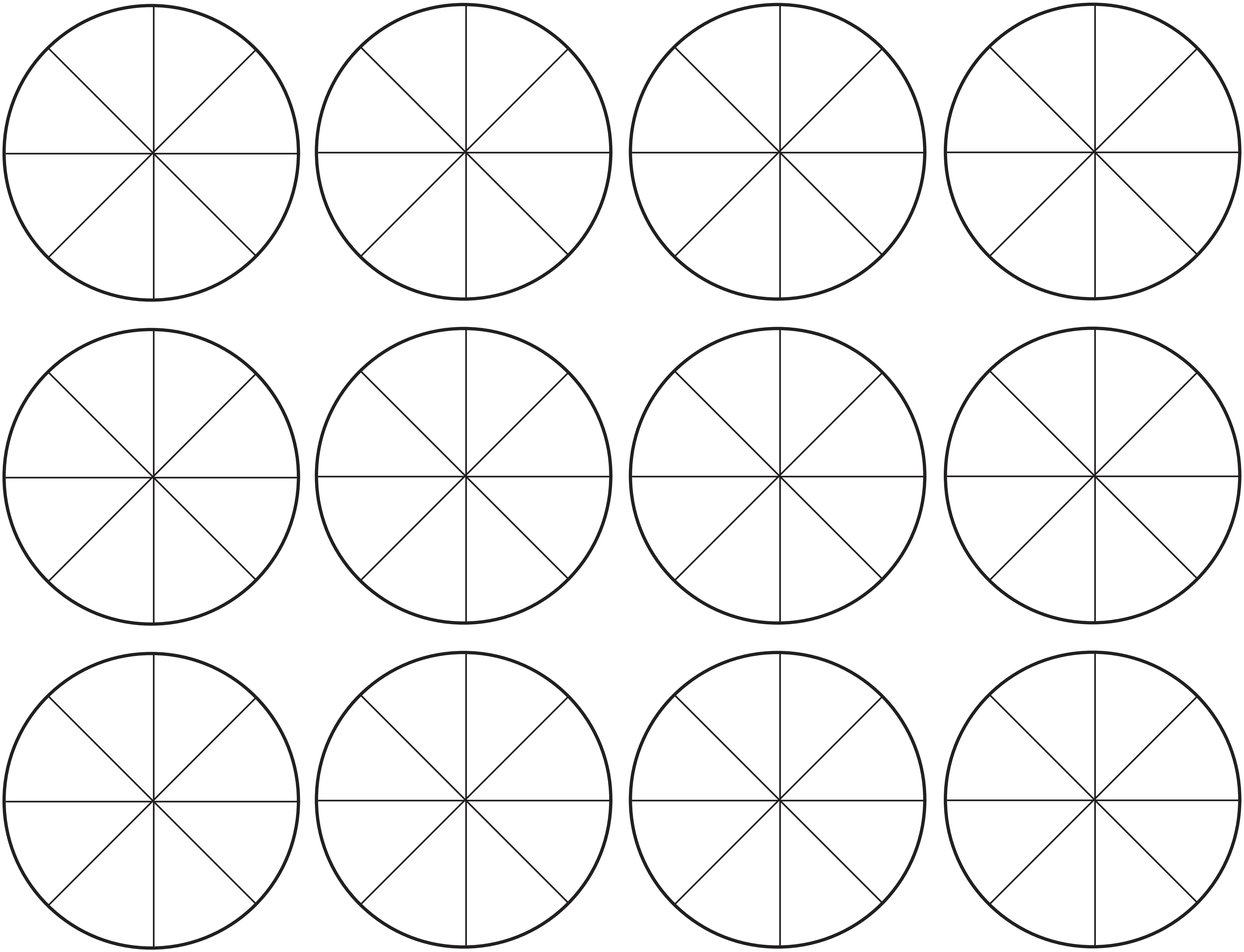
Bottom left: Use scissors to snip a tiny hole in the center of the color wheel. Place the color wheel on the motor's spindle.

Bottom middle and right: When the circuit is complete and electrical energy is flowing to the motor, the wheel will spin with increasing speed and appear to blend the colors together.









Sorting Scientists

Facilitate a game to help visitors learn about Lewis Latimer and Hakeem Oluseyi

The "Sorting Scientists" game helps visitors learn about Lewis Latimer and Hakeem Oluseyi—where they are from, what their research is about, and more. As they match facts with each scientist, visitors make connections to learning experiences included in the *Hidden No More* exhibit.

This game reinforces the exhibit's message that many kinds of people, often unknown to us, have helped us—and are helping us—by inventing technologies and making scientific discoveries. Because of them, we can have a better understanding of the Sun's mysterious atmosphere *and* a small electric light to keep us company when that same Sun seems to disappear at night!

RIGHT: The "Sorting Scientists" cards and magnetic board are set up, ready for play, at a back-to-school event in rural North Carolina.

MAIN IDEA

Visitors play a matching game with cards or magnets that display facts about Lewis Latimer and Hakeem Oluseyi.

EXHIBIT COMPONENTS

- Two options for setting up this activity are provided:

  [Option 1] Set of face cards (1 card for Lewis Latimer and 1 card for Hakeem Oluseyi) and fact cards (6 facts per scientist)

  [Option 2] Magnetic “Sorting Scientists” board and magnetic fact pieces (6 facts per scientist)

- Table large enough for the game to be spread out on it—and with space around it for the facilitator and up to four visitors.

Note: Assess the table height to be sure that all your visitors—including those who use wheelchairs—can reach it and see the cards.

TRY THE ACTIVITY

[Option 1] Card game. To begin, the facilitator places a picture card for Lewis Latimer and a picture card for Hakeem Oluseyi face up on the table. The fact cards are placed facedown. This allows visitors to discover each fact one at a time, consider it, and place it next to the picture of the scientist to whom it connects.

1. As you turn each card over, try to match the fact with one of the scientists.
2. There are six fact cards for each scientist. How many can you match?
3. This is not a test—you can discuss the facts and ask for answers (or just for hints and clues before you make your choices)!

[Option 2] Magnetic game. Same as Option 1, but the facilitator can place the fact pieces on the table and invite visitors to place each fact in the matching scientist’s column on the magnetic board.

GUIDING QUESTIONS

- What clues helped you match the facts to the scientists? Did you see patterns or notice that some facts probably happened long ago (e.g., invention of the telephone) or more recently (e.g., theory of relativity)?
- Did you already know about these scientists before you came here today? (Guide the visitor to a related video, panel, or other resource in the exhibit that will help them learn more about a scientist who has particularly sparked their interest.)

FACILITATION TIPS

This facilitated activity can be played by one or more visitors at a time. A family or a small group of friends, for example, can have fun playing together—reading each card aloud and discussing it before making a choice.

If there is room to do so, set up the game near the monitor showing the documentary video about Hakeem Oluseyi and the animated video about Lewis Latimer. This can help participants recall and make connections.

While the game can be played at any time during a visit, students who tested "Sorting Scientists" indicated they felt it was best played after visitors had experienced other parts of the exhibit first.

MAKE CONNECTIONS

Help visitors notice connections between Lewis Latimer and Hakeem Oluseyi. Though born more than 100 years apart, these scientists have a lot in common, such as:

- **Both of these African American men faced difficult circumstances when they were young.**
- **They are avid, self-motivated learners—*and* they are educators, sharing their scientific knowledge and practical advice with the public.**
- **They have multiple patents for their inventions.**
- **They have helped us understand more about the science of light and energy—from the glow of an electric light bulb to the charged atmosphere of the Sun.**

ANSWER KEY

Lewis Latimer

I was born free in Massachusetts in 1848 after my parents escaped slavery.

I helped Alexander Graham Bell patent his invention—the telephone.

I taught myself technical drawing and helped inventors get patents.

I worked for General Electric.

I invented a method for making stronger carbon filaments.

I worked for Thomas Edison and helped his incandescent light business grow.

Hakeem Oluseyi

I am an astrophysicist, professor, inventor, and science communicator.

I grew up in rural Mississippi.

I started teaching myself relativity at the age of 10.

I took my first physics class in college and realized this must be my major.

I am attracted to the universe, nature, and weirdness.

I speak to and inspire others to careers in STEM.

Animated Video

Lewis Latimer
(1848–1928)

MAIN IDEA

Visitors engage with a short, animated video to learn about the life and accomplishments of Lewis Latimer, including his involvement with two significant inventions—the telephone and the electric light bulb.

EXHIBIT COMPONENTS

- ELO touchscreen video monitor and Brightsign media player
- Information sign (with sign holder)

GUIDING QUESTIONS

- What did you find most interesting about Mr. Latimer's story?
- If you could have lunch with Mr. Latimer, what questions would you have for him?
- What did you think when Mr. Latimer asked you (the viewer) how telephones and light bulbs have changed since his time?

MORE TO LEARN ABOUT LEWIS LATIMER

Lewis Latimer was the son of enslaved African Americans. His parents escaped from slavery in Virginia to Massachusetts, where Lewis was born.

The 16-year-old Latimer joined the Union Navy during the Civil War. Afterward, he worked as an assistant in a patent law firm. There, he learned how to make patent drawings and prepare patent applications for inventors. One of the inventors he helped was Alexander Graham Bell. Latimer became an inventor, too.

Latimer joined Hiram Maxim's United States Electric Lighting Company in 1880. At that time, many companies were working hard to figure out how to provide electricity to American homes and businesses. In 1881, Latimer and his coworker Joseph Nichols patented a better way to attach a carbon filament, making it possible for light bulbs to last longer. In 1882, he patented a more efficient way to manufacture carbon filaments. Latimer supervised the installation of electric lighting equipment in Montreal, New York, and Philadelphia, even climbing telegraph poles himself to do so! He also set up the company's light-bulb factory in London.

In 1883, Latimer was hired by the Edison Electric Light Company, where his legal expertise was invaluable in protecting the company's patents in the rough-and-tumble of the early electric light industry.

In addition to his other accomplishments, Latimer was an effective science communicator. He knew that in order for people to electrify cities, they would need to understand how electrification worked. His book *Incandescent Electric Lighting: A Practical Description of the Edison System* (1890) details how generators start the process, how wires transmit electricity, and how incandescent lights work.

Documentary Video

Hakeem Oluseyi (born in 1967)

MAIN IDEA

Visitors engage with a short documentary video to learn about contemporary scientist Hakeem Oluseyi. They learn how his childhood experiences led him to become an astrophysicist who is inspiring new generations of scientists.

EXHIBIT COMPONENTS

- ELO touchscreen video monitor and Brightsign media player
- Information sign (with sign holder)

GUIDING QUESTIONS

- What did you find most interesting about Dr. Oluseyi's story?
- Why did Dr. Oluseyi choose to major in astrophysics when he went to college?
- If you could have lunch with Dr. Oluseyi, what questions would you have for him?

MORE TO LEARN
ABOUT HAKEEM OLUSEYI

Hakeem Oluseyi is an astrophysicist, inventor, and science communicator. Born in the deep South, he became interested in science as a child, when he taught himself the theory of relativity.

Visitors to the *Hidden No More* exhibit hear his story of growing up in humble circumstances—in rough urban neighborhoods and the rural South. He seemed to have an unlikely start as a scientist. But, even as a child, he had an active mind and was an avid reader. He was interested in nature, the universe, and fantastic adventure stories. Following these interests made him receptive to Einstein's groundbreaking theory of relativity, which he discovered in a set of encyclopedias that his mother had invested in for their home.

Oluseyi graduated as valedictorian from his high school in Mississippi. But he struggled in college because he had never taken advanced classes before, so he dropped out. After working as a janitor and struggling financially, he returned to Tougaloo College and graduated with a degree in physics and mathematics.

In the 1990s, while a graduate student at Stanford University, Oluseyi helped design and build a spacecraft that introduced important new methods for imaging the Sun and its corona. Later, he was awarded patents for his inventions related to making semi-conductors based on his solar research. Now, he still studies stars, and is known for his research on the transfer of mass and energy through the Sun's atmosphere.

Oluseyi has worked with various organizations that bring science to underserved populations, and he has appeared in multiple *TV* shows about the universe. Oluseyi has a sense of responsibility to new generations, with whom he shares his story of becoming an astrophysicist. He has also told this story in an autobiography, *A Quantum Life: My Unlikely Journey from the Street to the Stars*, first published in 2021.

Virtual Reality Experience

Lewis Latimer
Electrifying Light

MAIN IDEA

Visit Lewis Latimer's workshop in New York City near the end of the 19th century—and participate in the fierce competition to develop a practical electric light bulb.

Participants are guided through the steps of building an electric light bulb and creating an electrical circuit to power it. They use their hands to manipulate the technology in the workshop—to draw a filament, move the handle on a vacuum pump, switch the power on, and more. Participants can sit or stand to interact with this activity.

EXHIBIT COMPONENTS

- Oculus Quest 2 headset with case
- Round floor mat with feet (for standing use or with a chair in the center)
- Charging cord

EXHIBIT COMPONENTS, continued

- Sanitizing wipes

Note: Make a chair available for visitors who will need to sit down to take part in this activity. For example, some visitors may rely on a cane or walker to steady themselves when they are standing. Being provided a chair will allow them to use both of their hands to engage with the VR experience.

GUIDING QUESTIONS

- Tell me how you helped Lewis Latimer with his experiment. What did you discover?
- What was the coolest part of the experience, in your opinion?
- If you could go back into Lewis Latimer's workshop and work on your own invention there, what would you want to invent? Would you want to invent a new kind of light bulb—or would you want to invent something else?

MAKE CONNECTIONS

TO OTHER EXHIBIT RESOURCES

Ask a guiding question: "If you could go back into Lewis Latimer's workshop and bring something from the *Hidden No More* exhibit to share with him, what would you bring? What do you think his reaction would be?" Some ideas for what visitors might choose to show Mr. Latimer: the UV flashlight, the LED light bulb, the video monitor. Can they imagine what he would think about the Oculus headset and virtual reality?!

Virtual Reality Experience

Hakeem Oluseyi
Solar Winds

MAIN IDEA

Go to work in the "Telescope Control Center" in Washington, D.C., where Dr. Hakeem Oluseyi will task you with observing the Sun for signs of potentially dangerous solar winds. Dr. Oluseyi will train you to use space telescopes, a coronagraph, and ultraviolet light to make your observations.

Participants can sit or stand as they use their hands to mark the coronal holes rapidly appearing in the Sun's atmosphere. Coronal holes are cool spots where solar winds are strongest.

EXHIBIT COMPONENTS

- Oculus Quest 2 headset with case
- Round floor mat with diagrams of foot positions (for standing use, or for use with a chair in the center)
- Charging cord

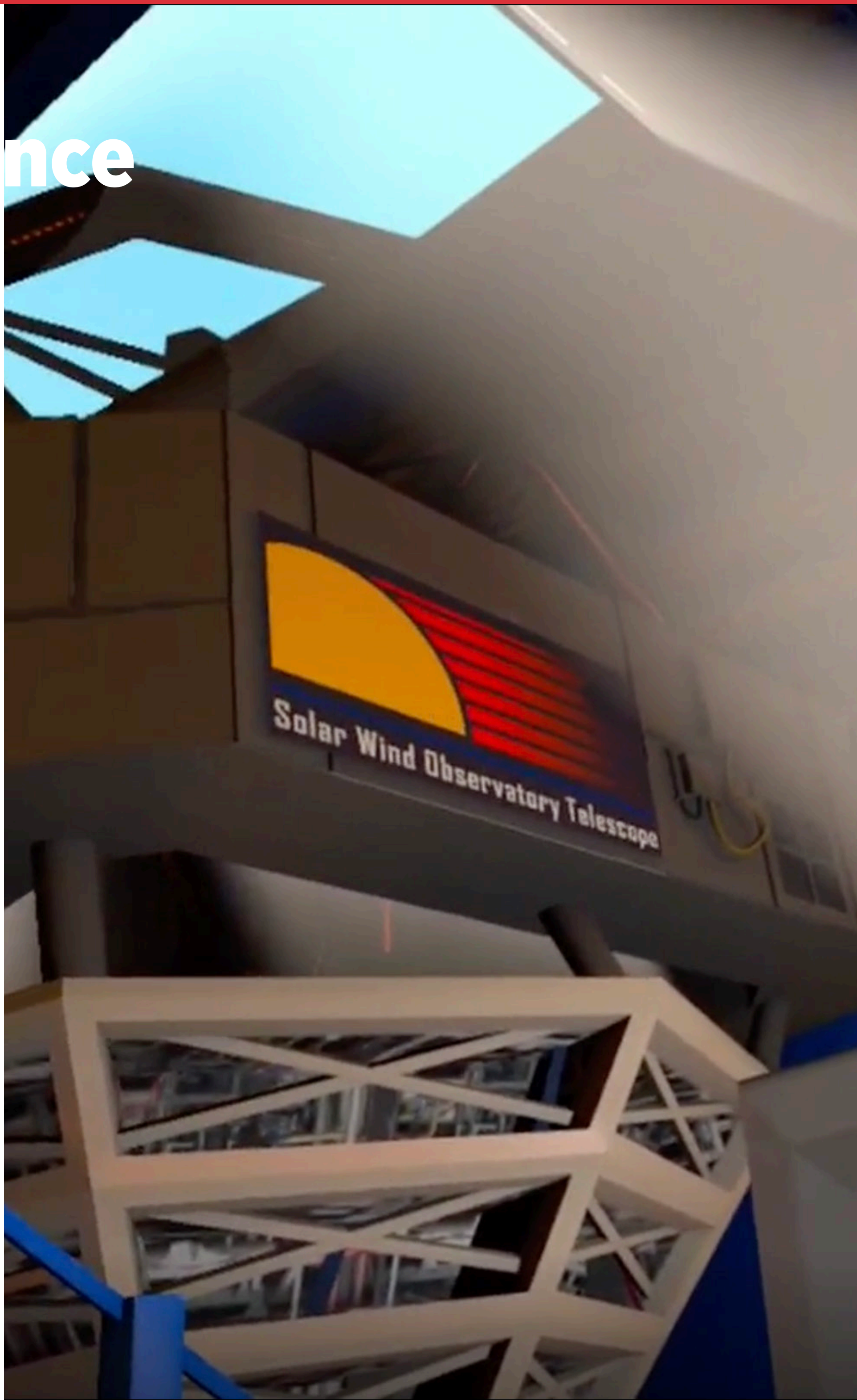


EXHIBIT COMPONENTS, continued

- Sanitizing wipes

Note: Make a chair available for visitors who will need to sit down to take part in this activity. For example, some visitors may rely on a cane or walker to steady themselves when they are standing. Being provided a chair will allow them to use both of their hands to engage with the VR experience.

GUIDING QUESTIONS

- Tell me how you helped Hakeem Oluseyi. What was the most interesting (or coolest) part of the experience for you?
- The Sun's atmosphere is constantly changing. How can observing these changes with telescopes help us protect spacecraft, astronauts, and even communication systems here on Earth?
- If you could make another visit to the "Telescope Control Center," what would you like to study? Would you like to find out something else about the Sun (which is Earth's star)? Or are you curious about stars beyond our solar system?

MAKE CONNECTIONS

TO OTHER EXHIBIT RESOURCES

Encourage visitors to try the "Discover the Sun's Atmosphere" hands-on activity to learn more about the corona, the Sun's outer atmosphere, and ultraviolet (UV) light. Using the Sun and Moon models to create different types of eclipses will help visitors understand how coronagraphs on board space telescopes, which the VR experience simulates, cover the Sun's bright disk so that the constantly changing corona can be studied.

Selected Sources

ABOUT THE SUN'S CORONA

Interrante, A. (2018, July 27). *NASA's Parker Solar Probe and the curious case of the hot corona.* NASA. https://www.nasa.gov/science-research/heliophysics/nasas-parker-solar-probe-and-the-curious-case-of-the-hot-corona/

NASA. (2024, March 29). *What is the Sun's Corona?* Space Place. https://spaceplace.nasa.gov/sun-corona/en/

NASA. (2020, July 27). *The very latest SOHO images.* SOHO: Solar and Heliospheric Observatory. https://soho.nascom.nasa.gov/data/realtime-images.html

NOAA. (n.d.). *LASCO coronagraph.* NOAA/NWS Space Weather Prediction Center. https://www.swpc.noaa.gov/products/lasco-coronagraph

School of Mathematics and Statistics, University of St Andrews. (2023, July 6). *First photograph of the solar corona.* The History and Science of Total Solar Eclipses. https://eclipse-history.wp.st-andrews.ac.uk/first-photograph-of-the-solar-corona/

Weisberger, M. (2017, July 5). *What were the first records of solar eclipses?* Space.com. https://www.space.com/37399-first-records-solar-eclipses.html

Weitering, H. (2017, July 28). *1st photo of a total solar eclipse was taken 166 years ago today.* Space.com. https://www.space.com/37656-first-total-solar-eclipse-photo-ever.html

ABOUT THE ELECTROMAGNETIC SPECTRUM

NASA. (2022, July 22). *NASA's Webb captures dying star's final "performance" in fine detail.* Flickr. https://www.flickr.com/photos/nasawebbtelescope/52212049510/

NASA. (2018, February 8). *Multiwavelength Milky Way: The Nature of Light.* https://asd.gsfc.nasa.gov/archive/mwmw/mmw_EM.html

NASA. (2010). *Ultraviolet Waves.* https://science.nasa.gov/ems/10_ultravioletwaves/

World Health Organization. (2016, March 9). *Radiation: Ultraviolet (UV) radiation.* https://www.who.int/news-room/questions-and-answers/item/radiation-ultraviolet-(uv)

ABOUT CONDUCTORS AND INSULATORS (INVENTIONS)

Benvenuto, M. (2023, December 15). *The lightest of collections: Aluminum coins.* https://www.numismaticnews.net/. https://www.numismaticnews.net/collecting-101/the-lightest-of-collections-aluminum-coins

Bellis, M. (2019, July 13). *Do you know who invented the paperclip, and how it happened?* ThoughtCo. https://www.thoughtco.com/history-of-the-paper-clip-4072863

Cole, A. E. (2019, May 28). *The history of the pencil.* Untold lives blog. https://blogs.bl.uk/untoldlives/2019/05/the-history-of-the-pencil.html

Foster, G. R. (2011, Summer). *John Harry Stedman: His busy life and weird inventions.* EPITAPH: the Friends of Mount Hope

SELECTED SOURCES, continued

Cemetery. Retrieved from https://www.lib.rochester.edu/IN/RBSCP/Epitaph/ATTACHMENTS/31_3.pdf

Graphite grading scale explained. Pencils.com. (n.d.). https://pencils.com/pages/hb-graphite-grading-scale

Latimer, L. H. (1890). *Incandescent electric lighting: A practical description of the Edison system.* D. Van Nostrand.

Madgwick, W. (2000). *Inventions (Kingfisher Questions and Answers).* Kingfisher.

U.S. Mint. (n.d.). *Nickel.* U.S. Mint Coin Classroom. https://kids.usmint.gov/learn/kids/about-the-mint/nickel

U.S. Mint. (n.d.). *Penny.* U.S. Mint Coin Classroom. https://www.usmint.gov/learn/kids/coins/fun-facts/category/penny

ABOUT LEWIS LATIMER'S LIFE AND INVENTIONS

Encyclopædia Britannica, inc. (n.d.). *Lewis Latimer.* Britannica Kids. https://kids.britannica.com/students/article/Lewis-Latimer/312102

Fouché, R. (2005). *Black inventors in the age of segregation: Granville T. Woods, Lewis H. Latimer, and Shelby J. Davidson.* Johns Hopkins University Press.

Latimer, L. H. (1890). *Incandescent electric lighting: A practical description of the Edison system.* D. Van Nostrand.

Massachusetts Institute of Technology. (n.d.). *Lewis Latimer: Improvement to the carbon-filament used for light bulbs.* Lemelson-MIT. https://lemelson.mit.edu/resources/lewis-latimer

Poole, D. F. (n.d.). *Maxim carbon lamp.* National Museum of American History . https://americanhistory.si.edu/collections/search?edan_

Rutgers-New Brunswick. (n.d.). *Latimer's patents.* Thomas A. Edison Papers, Rutgers, The State University of New Jersey. https://edison.rutgers.edu/resources/latimer/latimer-s-patents

ABOUT HAKEEM OLUSEYI 'S LIFE AND INVENTIONS

American Museum of Natural History. (2019, December 21). *Hacking the Stars with Hakeem Oluseyi – AMNH SciCafe* (Dec. 4, 2019). YouTube.

Holbrook, J., & Phillips, K. (Producers), & Phillips, K. (Director). (2017). *Black Suns: An Astrophysics Adventure* [Video file]. Retrieved from https://vimeo.com/ondemand/blacksuns eclipse/

Jones, M. A. (2016, October 11). *Astrophysicist and HBCU grad Hakeem Oluseyi is making waves.* Andscape. https://andscape.com/features/astrophysicist-and-hbcu-grad-hakeem-oluseyi-is-making-waves/

Justia. (n.d.). *Patents by Inventor Hakeem Oluseyi.* Justia. https://patents.justia.com/inventor/hakeem-oluseyi

Oluseyi, H. M., & Horwitz, J. (2023). *A Quantum Life: My unlikely journey from the street to the stars* (Adapted for young adults). Ember, an imprint of Random House Children's Books.