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Leap into science

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Light and Shadow

ACKNOWLEDGEMENTS

AUTHORS: Rachel Castro-Diephouse, Tara Cox, Julia Skolnik, Dale McCreedy, Peg Szczurek, Lori McCracken

DESIGNER: Kelli Cavanaugh

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Table of Contents

What is Leap into Science?

OVERVIEW

Developed by The Franklin Institute Science Museum in Philadelphia, PA, Leap into Science is a national program designed to build interest and skills in science and literacy for children ages 3–10 and their families, in community settings like libraries, museums, and out-of-school time programs. The program originated in 2007 through a partnership with the Free Library of Philadelphia, with the goal of engaging underserved children and families across Philadelphia in science and literacy learning. In partnership with the National Girls Collaborative, Leap into Science is now being disseminated through state partnerships between museums, libraries, out-of-school time organizations, and others, to reach a broader and more diverse audience of children and families nationwide. For more information, visit leap.fi.edu.

KEY ELEMENTS OF WORKSHOPS

- Integrate **open-ended science activities with children's books** to highlight critical thinking skills that are important in both science and literacy.
- Provide opportunities to **think like a scientist** by making observations and predictions, testing ideas, and learning from something that may not have worked as planned.

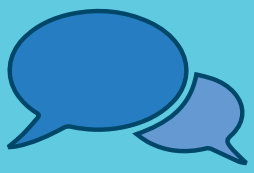
PROGRAM GOALS

- For **children and families** to have fun exploring science and books together, think scientifically, and build positive attitudes toward science learning in informal community settings.
- For **educators** to build knowledge, skills, and confidence in leading engaging science and literacy learning experiences for children and families.
- To build partnerships between **informal organizations** like libraries, museums, and out-of-school time organizations, and build their capacity for engaging underserved communities in science and literacy learning.

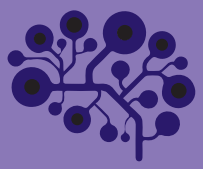
Leap into science core four

Ask Questions

Encourage Scientific Thinking



Cultivate Rich Dialogue



Make Connections

Leap into Science Core Four Strategies

For Building Science and Literacy Skills

1. Ask Questions

Ask questions when reading stories and exploring science concepts to deepen children's thinking and engagement.

Why:

- Questions bring out people's natural curiosity, motivating them to explore and learn.
- Questions allow children to express their ideas through language.

How:

- Ask *open-ended* questions—questions with multiple possible responses—to help children explain their thinking. Examples: *What do you notice? Why do you think that?*
- Ask *closed-ended* questions—questions with one or a few possible responses—to guide children toward a particular area of focus. Examples: *Where do you think the balancing point is? Where did the ball go when it fell?* Often follow up with an open-ended question: *Why do you think that? How can you tell?*

2. Encourage Scientific Thinking

Encourage children and their caregivers to think scientifically by observing, asking questions, making predictions, testing their ideas, and learning from repeated attempts.

Why:

- These practices strengthen critical thinking skills that are essential in both science and literacy learning.
- Focusing on the *process* of science rather than a specific *product* or outcome frees children and their caregivers to explore and take risks.

How:

- When reading a storybook, invite children to make observations about the book's cover, predict what they think will happen next, ask questions about the illustrations, and draw conclusions about the story.
- During science explorations, point out occasions when people notice things, guess what will happen, test a new idea, or learn from something that didn't work.
- Model scientific thinking yourself. If you don't know the answer to a participant's question, respond with: *I don't know! Let's find out together!*

3. Cultivate Rich Dialogue

Provide opportunities for children and their caregivers to learn new vocabulary words, use them in different contexts, and have meaningful conversations while learning together.

Why:

- Literacy skills develop when children use language in relevant contexts, such as everyday science concepts. Similarly, science learning requires language through describing, questioning, and communicating ideas.
- Rich dialogue during learning allows people to explore new concepts together, and strengthen their ability to express their ideas.

How:

- Define and use key vocabulary during the explorations.
- Encourage children and families to connect their ideas and discoveries back to words and concepts from the book(s).
- Encourage children and their caregivers to explain their ideas to each other during their explorations.

4. Make Connections

Connect learning experiences to people's everyday lives and interests to make the learning more meaningful and memorable.

Why:

- People understand new information better, and are more motivated to learn, when the topic is connected to their own experiences.
- Highlighting how children behave like scientists during their explorations can help them see themselves as scientists, and potentially increase their future interest in science careers.

How:

- Draw connections between children's everyday experiences and the books, activities, and science concepts by asking children about their interests relating to the topic; for example: *What do you like to do outdoors? What is it like to do that on a windy day?*
- Encourage children and their caregivers to reflect on the ways they were scientists during the workshop. Ask questions like *How did you feel like a scientist today?* or use a book, such as *What is a Scientist?* by Barbara Lehn, to guide the discussion.
- Introduce children and their caregivers to science role models who reflect their race, ethnicity, gender, and/or cultural background, either in person or through books, photos, articles, or credible websites.

Choosing Books for Leap into Science

Leap into Science workshops incorporate children's picture books in two key ways: **read-aloud stories** and **exploratory books**. The guidelines below outline important criteria for choosing books for each category. Specific books that follow these guidelines are recommended for each Leap into Science workshop. You are also encouraged to select alternate books that meet these criteria in order to best match the experiences and needs of your audience.

READ-ALOUD STORIES

PURPOSE: The read-aloud story plays a crucial role in every Leap into Science workshop. It introduces key science ideas and vocabulary to children and families through a comfortable and engaging group experience. This story lays a foundation for the concepts that will be explored later in the workshop, while providing interactive opportunities for children and families to connect these ideas to their personal experiences.

Look for:

Captivating story

Clear and accurate science concepts

Relevant ethnicity, culture, and language

Avoid:

Too long

Too much text

Too many unfamiliar words

Tips:

Keep the illustrations visible while reading

Pause during the story to encourage reflection

Characteristics to look for:

- **Captivating story.** Choose a book with a story that will hold your audience's attention. Children (and adults) are more likely to stay engaged and remember ideas when they are interested in what will happen next. Preschoolers generally prefer simple stories with compelling illustrations and only a sentence or two on each page; elementary-aged children can focus their attention on more complicated stories and longer texts.
- **Clear and accurate science concept.** Select a book that clearly and accurately illustrates the science concept(s) of the workshop through the story and the illustrations. For example, if the key idea is that objects create shadows by blocking light, the book should include multiple images or events in the story that accurately illustrate an object creating a shadow. It is also critical that the way the science concepts are presented in the book does not lead to misconceptions. For example,

stories depicting shadows as characters that move on their own might hinder children's understanding that a shadow's shape is caused by the object creating it. If a book does contain potentially misleading imaginary elements, be prepared to briefly discuss how and where the story is not scientifically accurate.

- **Relevant ethnicity, culture, and language.** Whenever possible, choose books that reflect the ethnicity, culture, and language of your audience. This allows children and families to make more meaningful connections to the content and to enrich their own identities as science learners.

Characteristics to avoid:

- **Too long**. Even with an engaging story, children may have difficulty maintaining attention if the book has too many pages or takes too long to read. Generally, reading the book should take no more than five to ten minutes, with a few additional minutes for reflective questioning and discussion.

- **Too much text**. Pay attention to how much text is on each page of the book. Seeing a new page of illustrations every few sentences keeps children engaged and helps them visually connect with the words they are hearing. Books with long paragraphs of text between page turns or with only small illustrations may challenge children's ability to focus on the story and the science concepts you are introducing. If a book has strong illustrations but too much text, consider reading only one or two key sentences from each page, or instead use it as an exploratory book later in the workshop (see suggestions below).

- **Too many unfamiliar words**. While children don't need to know every word in a story, too many unfamiliar words will get in the way of their understanding. Think carefully about how many words in the book might be unfamiliar to your audience. You can pause to explain or define a key word or two during the read-aloud if necessary, but if there are more than three important words that will need explanation in addition to your science concept, consider using it as an exploratory book instead (see suggestions below).

Tips for using read-aloud books during workshops:

- **Keep the illustrations visible while reading**. Hold the book open to the side of you as you read the text, keeping the illustrations visible to the audience at all times. This maximizes comprehension for children by helping them to visualize the story as they hear it.

- **Pause during the story to encourage reflection**. Select places in the story to pause and ask a reflective question that allows children to notice something in the illustrations, make a prediction about what will happen next, or reflect upon what happened in the story. This builds skills in active listening and rich comprehension while reading.

EXPLORATORY BOOKS

PURPOSE: Exploratory books extend the concepts of the read-aloud story and science explorations in Leap into Science workshops by providing additional information or context for the science ideas. They can be used to complement tabletop activities or in a reading station for children and families to explore on their own. Exploratory books can also be referenced during a reflection at the end of a workshop, using one or two pages from the book to present a new perspective or to introduce a science role model.

Look for:

Accurate science content and engaging illustrations

Relevant ethnicity, culture, and language

Books that highlight the process of science

Avoid:

Outdated science content

Text-only books

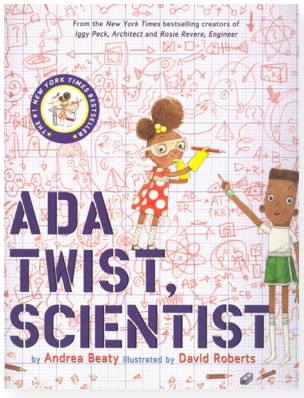
Tips:

Use illustrations to support exploration

Highlight diversity to build science identity

Characteristics to look for:

- **Accurate science content and engaging illustrations**. Choose fiction, nonfiction, or informational books with accurate science content to allow children and families to learn more about the science concepts introduced in the workshop. Photos or illustrations that clearly demonstrate the concepts provide a way to engage with the information even for those who are not able to read the text.
- **Relevant ethnicity, culture, and language**. Whenever possible, choose books that reflect the ethnicity, culture, and language of your audience. This allows children and families to make more meaningful connections to the content and to enrich their own identities as science learners.
- **Books that highlight the process of science**. Include books that show children engaged in the process of science, such as *What Is a Scientist?* by Barbara Lehn or *Ada Twist, Scientist* by Andrea Beatty. These books connect families' explorations during the workshop with science skills and help children identify themselves as scientists.



Characteristics to avoid:

- **Outdated science content.** Scientific research continually leads to new discoveries and changes in our understanding of the world around us. Check for up-to-date content and avoid books where current research or terminology may have advanced past what is represented in the book.
- **Text-only books.** While exploratory books may contain more text than a read-aloud book, avoid chapter books or those with long blocks of text and few illustrations. Books that allow children and families to engage by looking at a few pages or reading a short story are more conducive to collaborative exploration of science ideas.

Tips for using exploratory books during workshops:

- **Use illustrations to support exploration**. Emphasize a relevant illustration that relates to a tabletop activity by bookmarking the page or placing the book open to that page at the activity station. During explorations, point out individual photos as examples for inspiration or to support problem-solving. For example, show a picture of a small object making a large shadow to illustrate how an object's shadow can change size.
- **Highlight diversity to build science identity.** Create opportunities to highlight images and stories that illustrate diverse characters and cultures, which help children and families connect their own experiences with scientists and science practices. Read a relevant page from a book to a small group, or point it out to a caregiver to share with their child. During a workshop's closing reflection, incorporate a book that shows children engaging in science or that introduces a science role model whose background is similar to that of your audience.

About Light and Shadow

Our sense of sight relies on the presence of light. However, since light is not visible as it travels through air, it is not always obvious how important light is in creating the world we see. Light bouncing off objects gives them their color and creates reflections in shiny surfaces. Objects that block light create shadows that move and change as the object moves. The Leap into Science light and shadow workshops invite children and families to experiment with light and explore the ways that light interacts with objects to create shadows, reflections, and more.

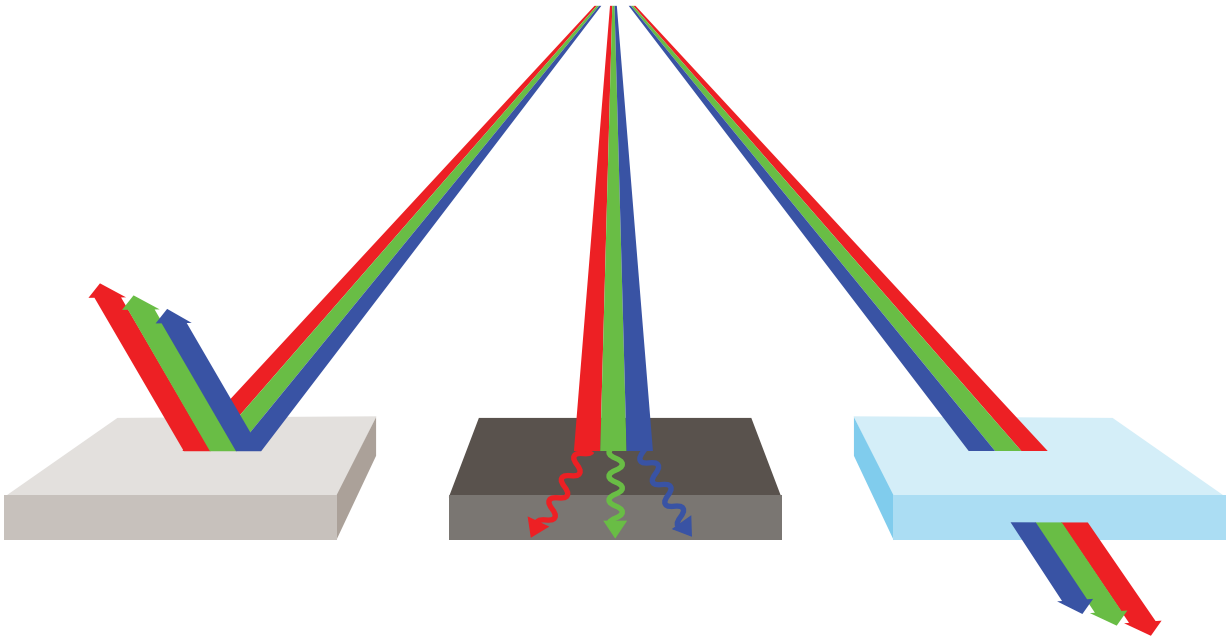
SCIENCE IDEAS

- **Light travels in straight lines.** Light is a form of electromagnetic energy. When light leaves a light source (like the sun or a flashlight), it moves outward on a straight path until it meets an object that stops or redirects it. We can't see light as it travels through the air, but we can see how it interacts with other objects. When you turn on a flashlight, you can see the bright circle it makes on the object it is pointed at, but you can't see the light in the air between the flashlight and the object. However, if there is fog or dust in the air, the light interacts with the fog or dust particles, and you might be able to see the straight path of the light as it travels out from the flashlight.

- **Objects can block light or let it pass through.** When light hits an object, it interacts with the object in different ways, depending on the material from which the object is made. Some materials block light by reflecting or absorbing it. Light that reflects, or bounces off, objects is what makes the objects visible to our eyes. Many materials absorb some parts of the light and reflect others. Grass, for example, looks green because it reflects the part of the light that looks green to our eyes and absorbs all the rest. Other materials, such as air or glass, allow light to pass through, rather than absorbing or reflecting it. Air does not absorb or reflect any light, so light passes through it from other objects to our eyes. Window glass, on the other hand, lets most of the light pass through, but also reflects a small amount of the light. This is why you can see your reflection in a window as well as the objects on the other side. How well a material blocks light determines whether it is **transparent** (most or all of the light passes through), **translucent** (blocks some of the light while some passes through), or **opaque** (blocks all of the light).

- **When an object blocks light from shining on a surface, it creates a shadow.** A shadow is simply an area where less light is shining on a surface because another object is absorbing or reflecting away some of the light. When you put your hand in front of a flashlight, your hand absorbs or reflects all the light that hits it, preventing that light from reaching the wall behind it. As you move your hand closer to the flashlight or change the position of your fingers, different areas of the light are blocked, which changes the visible shape of the shadow.

Properties of Light



Reflection **Absorption** **Transmission**

Shadows and Young Learners

For preschoolers, the goal of these explorations is **not** to fully understand or define light and shadow. Preschool children have had experiences with light and dark and know that light helps them see things. They can use their observation skills to talk about whether light is bright or dim and describe shapes of shadows as they relate to the objects that form them. Many preschool children believe that a shadow is a separate extension of the object that casts it. As a child moves and their shadow moves as well, it might appear to them that the shadow is living. However, some children at this age are beginning to understand that light makes shadows and that shadows aren't in fact alive. Direct experience with creating and changing shadows of inanimate objects will help younger children come closer to understanding this concept.

Light and Shadow Preschool Workshop

AUDIENCE

Children ages 3–5 and their caregivers

TIME FRAME

40–60 minutes

SUMMARY

Children explore the characteristics of light and shadow by listening to a story about shadows, hunting for shadows in their environment, and creating shadows with a variety of objects.

GUIDING QUESTIONS

- What do you need to make a shadow?
- How can shadows change?

KEY WORDS

Use these key vocabulary terms throughout the workshop to build understanding about light and shadow:

light

shadow

block

shape

PREPARE

1. Review the Light and Shadow Preschool Workshop Question Guide on p. 21 and think about when and how you will incorporate questions into your facilitation of the workshop. You may also wish to make copies of the Question Guide for caregivers to use during the workshop and/or to take home.

2. If possible, research people whose careers involve using or studying light and shadow (such as photographers, theater lighting designers, or astronomers). Look for people who represent the gender, racial, and cultural background of your audience, and/or who are local to your area.

3. Test that all of the flashlights are working properly and can create easily visible shadows. Replace the batteries as needed.

4. Set up the space:
   - Check that the lighting in your space is appropriate for making shadows. There should be enough light to create natural shadows around the space for children to find during the Shadow Hunt activity, while also allowing children to create clear shadows using the flashlights. If necessary, decide how and when you will adjust the lighting during the workshop.
   - Identify a blank area of wall or other vertical surface where you can create shadows. Test it by creating a shadow on it using one of the flashlights. Make sure that the shadow is well defined and clearly visible from where children will be sitting. If needed, hang a piece of chart paper or other white material on the wall to help the shadows appear more clearly.
   - Set up workstations for children by propping dry-erase boards against walls or other supports to create vertical surfaces for making shadows. Test that the flashlights create clear shadows on the boards, and adjust the boards' locations or the lighting level as needed.
   - Place the wooden blocks, plastic animals, cookie cutters, and any additional objects for making shadows in a central, accessible location, or divide them into individual bins for each child.
   - *Optional:* Create a book corner with recommended books and materials for drawing.

5. *Note*: This workshop is designed for each child to work individually with a flashlight and dry-erase board. If your group size is too large to give each child their own workstation, you could ask the children to work in pairs and assign clear roles to encourage cooperation. For example, ask one child from each pair to hold the flashlight and the other to place the objects, switching roles periodically.

MATERIALS

- A read-aloud book, such as: *Dreams* by Ezra Jack Keats
- *What Is a Scientist?* by Barbara Lehn
- Wooden blocks of various shapes (several per child)
- Plastic animals (several per child)
- Outline cookie cutters (several per child)
- LED flashlights (1 per child)
- Dry-erase boards (1 per child)
- Copy of **light** and **shadow** word cards, printed on card stock

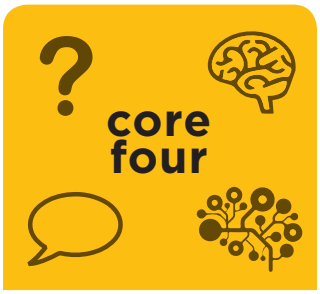
Optional Additional Materials

- Large sheet of blank paper, such as chart paper
- Bins or buckets for holding shadow objects
- Additional objects that create interesting shadows, such as whisks, colanders, translucent objects, etc.
- Replacement batteries for flashlights
- Additional books about light and shadow (see Recommended Book List)
- Paper
- Crayons or markers
- Photo, book, or article about a person whose career involves light and shadow

BOOK CHOICES: Use one of the recommended read-aloud books above, or choose an alternate book that follows the guidelines on pp. 8–10.

WELCOME (5 minutes)

- Welcome children and caregivers to the workshop. Introduce yourself to the participants.
- Explain that today's workshop was created by The Franklin Institute, a science museum in Philadelphia. The goals of the program are to have fun exploring light and shadow and to be scientists together.
- Set expectations for children's and caregivers' respective roles; for example: *Kids, you are the scientists today. Grown-ups, your job is to help your scientists—**ask questions**, and let your children take the lead!*



Words in bold highlight Core Four strategies
(see pp. 5–7 for details)

ENGAGE: Light and Shadow (5–10 minutes)

- Explain that the today's workshop is all about light. Introduce the **light** word card and invite the group to say the word with you. If possible, place the card in a visible location, where children can refer to it throughout the session. **Ask questions** that invite the group to think about light. For example:
  - *Where have you seen lights before?*
  - *What is it like when the sun is shining, or when a light is turned on in a room?*
  - *What is it like when there is no light?*
- Hold up a flashlight. **Make connections** to participants' everyday lives by asking about their experiences with flashlights.
  - *Have you seen or used something like this before?*
  - *What did you do with it?*
- Shine the flashlight on the blank area of wall. **Encourage scientific thinking** by inviting the group to make observations and predictions.
  - *What do you see on the wall?*
  - *Where is it bright, and where is it darker?*
  - *What do you think will happen if I turn the flashlight off? What if I turn it back on again?*
- Hold up your hand in front of the flashlight beam to create a shadow on the wall.
  - *What do you see on the wall now?*
  - *What does it look like? What shape is it?*
  - *Where does the wall look bright now, and where is it dark?*
- Introduce the **shadow** word card and invite the group to say the word with you. Place the card in a visible location for the rest of the session. **Cultivate rich dialogue** by asking children to talk about their experiences with shadows.
  - *Where have you seen a shadow before?*
  - *What did it look like?*

- Create a hand shadow again. Move your hand out of the light's path, but leave the flashlight on.
  - *What is different now?*
  - *Is there a shadow? How can you tell?*
- Replace your hand, and then turn off the flashlight, leaving your hand in position.
  - *Now what do you see?*
  - *Is there a shadow now? How can you tell?*
  - *What were the two things we needed to make a shadow of my hand?*
- Explain that a **shadow is made when an object blocks light**. Create a shadow again using the flashlight and your hand. **Encourage scientific thinking** by inviting the group to observe and predict how the shadow changes as you change elements of the system, for example, by changing your finger positions, angling the flashlight left or right, and moving your hand closer to or farther from the flashlight. **Ask questions** like:
  - *How did the shape of the shadow change when I moved my fingers? What does it look like now?*
  - *What happened to the shadow when I moved my hand closer to the flashlight?*
  - *What do you think will happen if I move it farther away?*

READ: Storytime (10 minutes)

- Transition to the storytime by explaining that you will now read a book to try to find out more about light and making shadows.
- Show the group the read-aloud book and introduce the title and author. **Encourage scientific thinking** by asking children to make observations about the cover of the book and predictions about the story:
  - *What do you notice on the cover of this book?*
  - *What do you think this story might be about? What makes you think that?*
  - *Where do you think we might see lights or shadows in this book?*
- Read the story, pausing to ask reflective questions. **Encourage scientific thinking** by inviting children to observe shadows in the story and illustrations and make predictions about what will happen next. **Ask questions** like:
  - *Where do you see shadows in this picture?*
  - *What do you think is making the shadow? How can you tell?*
  - *How does the mouse's shadow look the same as or different from the mouse?*
- **Make connections** between the shadows in the book and the previous exploration:
  - *What happened to my hand's shadow when I moved it far away from the wall?*
  - *How is that like what you see on this page?*

EXPLORE: Shadow Hunt (10–15 minutes)

- Explain that since the group has seen some ways to make shadows in the book, it is now time to find out what might be making shadows in this room. Encourage the group to think about light and shadow in the space where they are. **Ask questions** like:
  - *Where do you see light in this room? What things in this room are making light?*
  - *Can you see any shadows in this room? What do they look like?*
  - *Do you think there are other shadows in this room? What makes you think so?*
- Invite the group to go on a "shadow hunt" to see if there are shadows hiding in the room. Encourage children to explore the room individually and see how many different shadows they can find.
- If your space does not allow for children to safely explore independently, you could organize the shadow hunt in one of the following ways:
  - Lead the entire group in exploring the room together and ask children to point and call out "shadow!" when they see one. Stop the group and investigate shadows as they are spotted.
  - Have each adult present lead a smaller group of children in exploring the room together. Encourage them to use the Question Guide when exploring with their group.
- As children look for shadows, **encourage scientific thinking** by inviting them to make observations and draw conclusions about the shadows they find. **Ask questions** like:
  - *What does the shadow look like?*
  - *What object do you think is making the shadow? How can you tell?*
  - *How does the shape of the shadow look the same as the object? How is it different?*
  - *Where do you think the light is coming from to make the shadow? What makes you think that?*
- **Cultivate rich dialogue** by encouraging conversation between adults and children as they explore the room. Suggest questions (like the ones in the Question Guide) for adults to ask children about the shadows they find. Provide opportunities to reinforce the vocabulary words **light** and **shadow** during the exploration, such as:
  - *Where else do you think we could find a shadow?*
  - *Where do you see something making light?*
- **Make connections** by tying children's exploration to previous activities and discussions:
  - *Remember when I made a shadow on the wall? What other shadows can you find on the walls?*
  - *How is that shadow like the shadow we saw in the book?*
- *Optional*: If children have been exploring independently or in small groups, gather the whole group together and invite children to share about or show the group a shadow they found. **Cultivate rich dialogue** by asking them to talk about the shadow:
  - *Where did you find the shadow?*
  - *What does it look like?*
  - *What else can you tell us about the shadow you found?*

EXPLORE: Making Shadows (10–15 minutes)

- Explain that next the group will have a chance to find out even more about shadows by making shadows of their own.
- Gather the group near the dry-erase board workstations. Demonstrate how to turn on the flashlight and how to create a shadow by shining it at the dry-erase board and placing an object in front of it. If children are working in pairs, identify specific roles for each partner (such as holding the flashlight, placing objects, etc.) and explain how and when children will switch roles. Remind children not to point flashlights into their own eyes or other people's eyes.
- Invite children to explore making shadows with the blocks, animals, and cookie cutters. Encourage them to see what kinds of shadows they can make and to find different ways to change the shadows they create.
- As children investigate making shadows, visit individual children around the room and **ask questions** to help them create meaning and deepen their exploration:
  - *What do you notice about the shadow you made?*
  - *How is the shadow the same as the object? What is different about it?*
  - *What could you do to change the shape of the shadow? What else could you try?*
- **Encourage scientific thinking** by inviting them to observe what happens, make predictions, and try new things:
  - *How does the cookie cutter shadow look different from the animal shadow?*
  - *What do you think will happen if you turn the object sideways? How is the shadow's shape different now?*
- **Make connections** between children's explorations and their previous experiences in the workshop:
  - *How is this shadow like the one you found in the shadow hunt?*
  - *How could you make the shadow grow bigger like the mouse in the book?*
- **Cultivate rich dialogue** by inviting children to talk with each other or their caregivers about the shadows they make:
  - *I notice this person is making a different kind of shadow with that same animal. Let's ask her what she is doing.*
  - *What can you tell your friend about the shadow you made?*
- *Optional*: Invite children who finish earlier than others to read books and write or draw about their experiences in the reading area.

REFLECT: Discussion (5–10 minutes)

- Gather the group together to reflect on their experiences. Remind them of the different ways they explored light and shadow: seeing your hand shadow in the beginning, noticing shadows in the book, hunting for shadows in the room, and creating their own shadows with the flashlights. Invite children to think and talk about their own explorations by **asking questions** like:
  - *What kinds of shadows did you make or find today? How did their shapes look like the objects that made them?*
  - *What different lights helped to make the shadows?*
  - *Did anything happen that surprised you? What was it?*
- **Make connections** between children's actions and scientific practices by referencing pages from the book *What Is a Scientist?* and asking children to share their own examples. **Ask questions** like:
  - *How were you like a scientist today?*
  - *When did you make a guess about something and test it?*
  - *Was there a time when you tried something over and over?*
  - *Did you have fun?*
- If possible, share a photo, book, or article about a person whose job involves using or studying light. Look for examples of people who represent the gender, racial, and cultural background of participating children and families.
- End by thanking the group for doing great work as scientists. **Encourage scientific thinking** by inviting them to continue noticing how lights and objects make shadows outside and at home.

EXTEND: Additional Activity Ideas

- Take the group on a "light and shadow" hunt around the building or grounds. Ask children to call out "light" when they see something that is making light and "shadow" when they see a shadow.
- Look for and collect objects that make interesting shadows; for example, objects with holes (such as whisks or colanders) or translucent or transparent objects (such as plastic containers or colored cellophane). Invite children to explore how these objects create shadows and encourage them to find objects of their own to investigate.
- Invite children to make shadow puppets by attaching pre-cut shapes to the ends of wooden craft sticks or dowels. Encourage children to explore the shadows the puppets make and use them to tell a shadow puppet story.
- Make a shadow theater by hanging a white bedsheet with a bright lamp placed behind it. Invite one or two children to stand behind the sheet and create shadows with their bodies or other objects while the rest of the group tries to guess what they are doing or holding to create the shadow. Use the shadow theater to act out shadow plays or put on a shadow puppet show.

Light and Shadow Preschool Workshop Question Guide

Here are some key questions you can ask to guide children's explorations during the workshop.

WORKSHOP SECTION	ASK
ENGAGE: Flashlight Hand shadow	*What is it like when a* **light** *is turned on in a room?* *Where have you seen a* **shadow** *before?* *What two things did we need to make a* **shadow** *of my hand?* *How did the shape of the* **shadow** *change when I moved my fingers?*
READ: Storytime	*What do you notice about the cover of the book?* *What do you think will happen?* *Where do you see* **shadows** *in this picture?*
EXPLORE: Shadow hunt Making shadows	*How does the shape of the* **shadow** *look the same as the object? How is it different?* *How is that* **shadow** *like the* **shadow** *we saw in the book?* *What could you do to change the shape of the* **shadow***?* *What do you think would happen if you…?*
REFLECT: Group discussion Read *What Is a Scientist?* Introduce a scientist	*What kinds of* **shadows** *did you make or find today?* *What different* **lights** *helped to make the shadows?* *Did anything happen that surprised you? What was it?* *How were you like a scientist today?*

To find out more about The Franklin Institute and Leap into Science, visit leap.fi.edu.

Light and Shadow Elementary Workshop

AUDIENCE:

Children ages 6–10

TIME FRAME:

45–60 minutes

SUMMARY:

Children explore the characteristics of light and shadow by listening to a story, recreating shadow shapes, and designing shadow shapes of their own.

GUIDING QUESTIONS

- How does a shadow's shape relate to the shape of the object(s) that create it?
- How do the positions of a light, an object, and a surface affect the shape of the shadow they create?

KEY WORDS

Use these key vocabulary terms throughout the workshop to build understanding about light and shadow:

light

shadow

bright

dark

outline

PREPARE

1. Review the Light and Shadow Elementary Workshop Question Guide on p. 30 and think about when and how you will incorporate questions into your facilitation.

2. If possible, research people whose jobs involve using or studying light and shadow (such as photographers, theater lighting designers, or astronomers). Look for people who represent the gender, racial, and cultural background of your audience, and/or who are local to your area. Gather photos, books, or articles about them to share with the group.

3. Check all of the flashlights to make sure they are working properly and can create easily visible shadows. Replace the batteries as needed.

4. Cut the sheets of shadow challenge cards into individual cards.

5. Set up the space:
   - Check that the lighting in your space is appropriate for making shadows. There should be enough light to create natural shadows around the space for children to identify, while also allowing children to create clear shadows using the flashlights. If necessary, decide how and when you will adjust the lighting during the workshop.
   - Identify a blank area of wall or other vertical surface where you can create shadows. Test it by creating a shadow on it using one of the flashlights. Make sure that the shadow created is well defined and clearly visible from where children will be sitting. If needed, hang a piece of chart paper or other white material on the wall to help the shadows appear more clearly.
   - Set up workstations for children by propping dry-erase boards against walls or other supports to create vertical surfaces for making shadows. Place the wooden blocks in a central, accessible location, or divide them into individual buckets or bins for each child.
   - Set aside a flashlight and a cylinder-shaped block to use during the opening section.
   - *Optional*: Create a book corner with recommended books and materials for drawing.

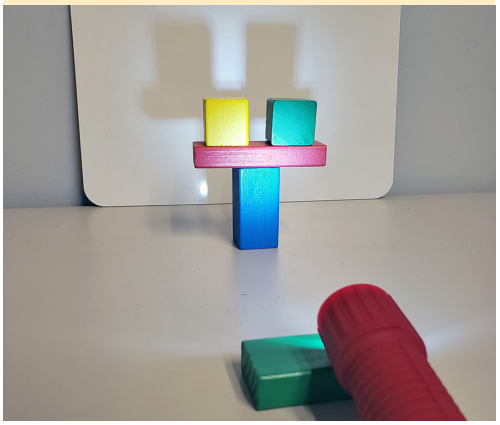
6. *Note*: Children may work either individually or in pairs during the shadow-making activities, depending on the size of your group. If children will be working in pairs, consider assigning clear roles to encourage cooperation. For example, ask one child from each pair to control the flashlight and the other to arrange the blocks, switching roles periodically.

MATERIALS

- A read-aloud book, such as: *Blackout* by John Rocco
- *What Is a Scientist?* by Barbara Lehn
- Wooden blocks of various shapes (several per child)
- Flashlights (1 per child or pair of children)
- Dry-erase boards (1 per child or pair of children)
- Copies of shadow challenge cards (1 set of 6 per 3–4 students; see Printable Resources)
- Copy of **light** and **shadow** word cards, printed on cardstock

Optional Additional Materials

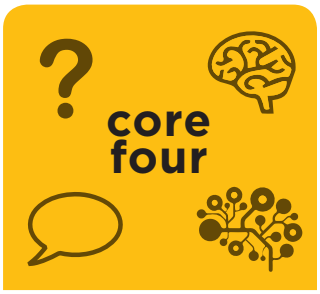
- Large sheet of blank paper, such as chart paper
- Bins or buckets for holding blocks
- Replacement batteries for flashlights
- Additional books about light and shadow (see Recommended Book List)
- Paper
- Crayons or markers
- Photo, book, or article about a person whose career involves light and shadow



BOOK CHOICES: Use one of the recommended read-aloud books above, or choose an alternate book that follows the guidelines on pp. 8–10.

WELCOME (5 minutes)

- Welcome children and caregivers to the workshop. Introduce yourself to the participants.
- Explain that today's workshop was created by The Franklin Institute, a science museum in Philadelphia. The goals of the program are to have fun exploring light and shadow and to be scientists together.
- Set expectations for children's and caregivers' respective roles; for example: *Kids, you are the scientists today. Grown-ups, your job is to help your scientists—ask them questions, and let your children take the lead!*



Words in bold highlight Core Four strategies
(see pp. 5–7 for details)

ENGAGE: Making Shadows (5–10 minutes)

- Explain that today's workshop is all about shadows. **Make connections** to children's everyday lives by asking about their experiences with light and shadow:
  - *Where have you seen a shadow before? What was it like?*
  - *What are some times or places where you can't see any shadows?*
  - *What do you think you need to have to make a shadow? What makes you think that?*
- Shine a flashlight on the wall and create a shadow by putting your hand in front of it. **Encourage scientific thinking** by inviting children to make observations and inferences about what they see. **Ask questions** like:
  - *What does the wall look like where the light is shining on it?*
  - *What does the wall look like where the shadow is?*
  - *Why do you think the wall looks darker where the shadow is? What makes you think that?*
  - *What do you think will happen if I turn off the flashlight?*
- Introduce the **light** and **shadow** word cards and invite the group to say the words aloud with you. Explain that **a shadow happens when an object blocks light from hitting a surface** (like the wall). If possible, place the word cards in a visible location, where children can refer to them throughout the session.
- Invite children to look around the room and identify light sources and shadows. **Cultivate rich dialogue** by asking children to describe their observations and thinking:
  - *Where do you see a shadow in this room? What does it look like?*
  - *What object do you think is making the shadow?*
  - *Where do you think the light is coming from that the object is blocking to make the shadow? What makes you think that?*

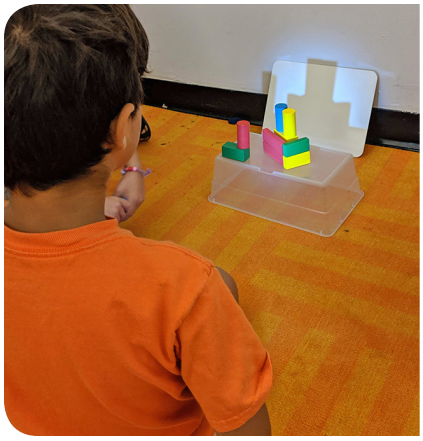
- Create another shadow on the wall, this time by holding a cylinder-shaped block upright in front of the flashlight to create a rectangular shadow. **Ask questions** that invite children to make observations about the shadow:
  - *What do you notice about the shadow?*
  - *Which parts of my hand and the block can you see in the shadow? Which parts don't you see?*
  - *If you traced the outline of the block's shadow, what shape would it make?*
- Next, turn the block with the circular end facing the light so it creates a circular shadow. **Encourage scientific thinking** by inviting children to compare the shapes of the shadows to the shape of the block:
  - *What shape is the block's shadow now?*
  - *Why do you think the two shadows looked so different if the block is the same shape? What parts of the block show in the shadow each time?*
  - *How could I move the block to make the shadow have a different shape?*
- Point out that moving the block is one way to change what the shadow looks like. Invite the group to consider what other factors might affect the shadow. **Ask questions** like:
  - *What else could we move or change that might make the shadow look different?*
  - *How do you think that would change the shadow? What makes you think that?*
- **Encourage scientific thinking** by testing some of the group's ideas. For example, change the position of the flashlight by moving it up and down, left and right, or near and far relative to the block. Invite the group to notice how the position of the light affects the shadow.
  - *What do you notice about how the shadow changes when I move the light nearer and farther away?*
  - *Where do you think the shadow will be if I move the light over here? What makes you think that?*

READ: Storytime (10 minutes)

- Transition to the storytime by explaining that the group will read a book to try to find out more about how shadows work.
- Show the group the read-aloud book and introduce the title and author. **Encourage scientific thinking** by asking children to make observations about the cover of the book and predictions about the story:
  - *What do you notice on the cover of this book?*
  - *What do you think this story might be about? What makes you think that?*
  - *Where do you think we might find shadows in this story?*
- Read the story, pausing to ask reflective questions. **Encourage scientific thinking** by inviting children to observe places in the story or illustrations where there are shadows and make predictions about what will happen next. **Ask questions** like:
  - *Where do you see shadows in this picture?*
  - *Where do you think the light is coming from to make the shadow?*
  - *What object do you think is making the shadow? Which parts of the object show in the shadow, and which parts don't show?*
- **Make connections** between the shadows in the book and the previous exploration:
  - *What happened to the shadows we made when I moved the flashlight up and down?*
  - *How is that like what you see on this page?*

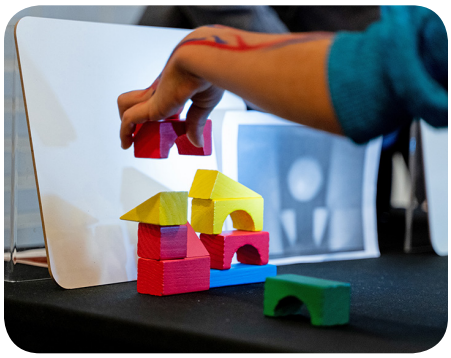
EXPLORE: Investigating Shadows (10 minutes)

- Explain that now the group will have the chance to find out even more about shadows by making shadows of their own.
- Gather the group near the dry-erase board workstations. Demonstrate how to turn on the flashlight and how to create a shadow by shining it at the dry-erase board and placing an object in front of the light. *Remind children not to point flashlights into their own eyes or other children's eyes.*
- Invite children to explore making shadows from different arrangements of blocks. Each child may work at their own station, or children may work together in pairs for large groups. As children explore, visit a few at a time and **ask questions** to help them create meaning and deepen their exploration:
  - *What did you notice about how that block's shadow changed as you moved it?*
  - *Which blocks could you use to make a shadow that is a triangle? What about a circle or square?*
  - *How could you create a shadow with an outline like a house?*
- Next, encourage children to investigate how they can change the size and location of the shadow by moving the flashlight or blocks. **Encourage scientific thinking** by inviting them to observe what happens, make predictions, and try new things.
  - *What happens if you hold the flashlight down lower? How does that change the shadow?*
  - *What do you think will happen to the shadow if you move the blocks closer to the board? What makes you think that?*
  - *How could you move the flashlight to make one side of the tower's shadow look bigger than the other?*
- **Make connections** between children's explorations and their previous experiences in the workshop and in their lives:
  - *Have you been outside and seen a shadow that was much bigger than its object?*
  - *How is that like what you just did with your tower's shadow?*
  - *Can you think of a shadow we saw in the book that looked like your shadow?*



EXPLORE: Shadow Challenges (15–20 minutes)

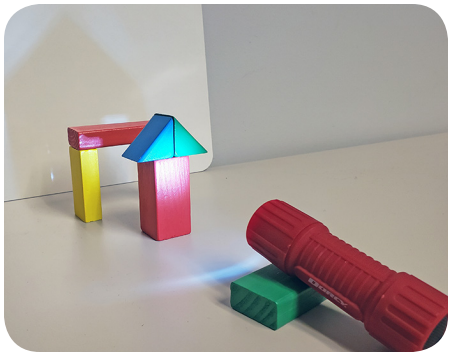
- Distribute the shadow challenge cards. Invite each child or pair of children to choose one of the cards and try to recreate the shadow from the card on their dry-erase boards using the blocks and flashlight.



- **Encourage scientific thinking** by encouraging them to make careful observations about their shadows, notice patterns, and try new things. **Ask questions** like:
  - *What do you notice about how far apart those shapes are in the shadow picture? How is that different from your shadow?*
  - *What happens to the size of the shadow as you move the block closer to the board or farther away?*
  - *What other blocks could you use to make a shape like this?*
- Invite children to exchange challenge cards as they complete them and try as many of the shadow challenges as time permits. **Cultivate rich dialogue** by encouraging children to work together on the challenges and discuss their ideas for how to recreate the shadows.
- Next, invite children to create their own shadow challenges. First, demonstrate how to create a shadow from an arrangement of 3–4 blocks and carefully trace its outline on the dry-erase board with a dry-erase marker. For a more difficult challenge, use 6–10 blocks.

- Disassemble your block structure, leaving the outline on the whiteboard. Explain that the outline will be like the challenge cards they just used. Another person or group will be challenged to build the structure again so that its shadow matches the outline.
- Invite children to create a challenge shadow by arranging blocks into an interesting shape, tracing the shadow, and disassembling the structure (but leaving the blocks together in a pile).
- Once they have made their shadows, challenge children to trade places with another child or pair and try to reconstruct their shadow from the blocks provided.
- As they work, **ask questions** that invite children to observe, try new things, and **make connections** to their previous explorations:
  - *What part of your shadow looks different from the outline? What could you move or change to make it match better?*
  - *Is there another way to make a shape like that with these blocks? What else could you try?*
  - *When you were matching the challenge card, what did you do to make a circle shape?*

- As time allows, encourage children to trade with multiple partners or pairs, or to create new challenge shadows for their partners to try. **Cultivate rich dialogue** by encouraging children to describe what they are noticing and trying and to share their ideas with each other.
- *Note*: Younger groups may take more time with the shadow exploration and challenge cards and shorten or omit the section on creating their own challenge shadows. Older groups may finish the challenge cards quickly and spend longer on creating their own challenge shadows.
- *Optional*: As an added level of difficulty for older groups, challenge children to make a "trick" shadow, where the shadow looks like a single object (a flower, a house, an animal) but is made from blocks that are separated—behind or in front of each other—in space.
- *Optional*: Invite children who finish earlier than others to read books and write or draw about their experiences in the reading area.



REFLECT: Discussion (5–10 minutes)

- Gather the group to reflect on their experiences. Remind them of the different ways they explored light and shadow: observing the cylinder block shadows, noticing shadows in the book, matching challenge card shadows, and creating their own shadow challenges. Invite children to think and talk about their own explorations by **asking questions** like:
  - *What shapes of shadows did you create today?*
  - *What are some things you did to change a shadow's size or shape?*
  - *Did anything happen that surprised you? What was it?*
- *Optional*: Invite children to share their favorite example of a shadow they made with a partner or the group. **Cultivate rich dialogue** by encouraging them to talk about how they created the shadow and what they like about it.
- **Make connections** between children's actions and scientific practices by referencing pages from the book *What Is a Scientist?* and asking children to share their own examples. **Ask questions** like:
  - *How were you like a scientist today?*
  - *When did you make a guess about something and test it?*
  - *Was there a time when you tried something over and over?*
  - *Did you have fun?*
- If possible, share a photo, book, or article about a person whose career involves using or studying light. Look for examples of people who represent the gender, racial, and cultural background of participating children and families.
- End by thanking the group for doing great work as scientists. **Encourage scientific thinking** by inviting them to continue noticing how lights and objects make shadows outside and at home.

EXTEND: Additional Activity Ideas

- Invite children to make shadow puppets by drawing shapes on sturdy construction paper or cardstock, cutting them out, and attaching them to the ends of wooden craft sticks or dowels. Encourage children to explore the shadows the puppets make and use them to tell a shadow puppet story.
- Make a shadow theater by hanging a white bedsheet with a bright lamp placed behind it. Use the shadow theater to act out a shadow play. Play shadow charades by inviting one child to stand behind the sheet and create a shadow shape or act out an activity while the rest of the group tries to guess what shape they are creating or what activity they are modeling.
- Explore other properties of how light interacts with objects. Set up activity stations from the Family Workshop and allow children to investigate how light is reflected, absorbed, and mixed together.

Light and Shadow Elementary Workshop Question Guide

Here are some key questions you can ask to guide children's explorations during the workshop.

WORKSHOP SECTION	ASK
ENGAGE: Lights and shadows in room Cylinder block shadows	*Where have you seen a* **shadow** *before? What was it like?* *What does the wall look like where the* **light** *is shining on it?* *Why do you think the two* **shadows** *looked so different if the block is the same shape?*
READ: Storytime	*What do you notice on the cover of the book?* *What do you think will happen?* *Where do you see* **shadows** *in this picture?* *Where do you think the* **light** *is coming from to make the* **shadow***?*
EXPLORE: Investigating block shadows Shadow challenges	*What did you notice about how that block's* **shadow** *changed as you moved it?* *What other blocks could you use to make a shape like this?* *What part of your* **shadow** *looks different from the outline? What could you move or change to make it match better?* *What do you think would happen if you…?*
REFLECT: Group discussion Read *What Is a Scientist?* Introduce a scientist	*What are some things you did to change a* **shadow's** *size or shape?* *Did anything happen that surprised you? What was it?* *How were you like a scientist today?*

To find out more about The Franklin Institute and Leap into Science, visit leap.fi.edu.

Light and Shadow Family Workshop

AUDIENCE:

Families with children ages 3–10

TIME FRAME:

40–60 minutes

SUMMARY:

In a series of activity stations, families investigate the characteristics of light and the ways it interacts with other objects.

GUIDING QUESTIONS

- How does light interact with objects and surfaces?
- How do objects block light to create shadows?

KEY WORDS

Use these key vocabulary terms throughout the workshop to build understanding about light and shadow:

light

shadow

reflect

transparent

translucent

opaque

PREPARE

1. Review the Light and Shadow Family Workshop Question Guide on p. 40 and think about when and how you will incorporate questions into your facilitation. You may also wish to make copies of the Question Guide for caregivers to use during the workshop and/or take home.

2. If possible, research people whose careers involve using or studying light and shadow (such as photographers, theater lighting designers, or astronomers). Look for people who represent the gender, racial, and cultural background of your audience, and/or who are local to your area. Gather photos, books, or articles about them to share with the group.

3. Check that all of the flashlights are working properly and can create easily visible shadows. Replace batteries as needed.

4. Check that the lighting in your space is appropriate for making shadows. There should be enough light that natural shadows occur around the space for families to identify during the workshop, while also allowing participants to create clearly visible shadows at the stations using the flashlights. If necessary, decide how and when you will adjust the lighting during the workshop or if you may need to use additional materials to create darker areas.

5. Set up the activity stations on different tables around the room. Allow space for 4–6 people to work at each station. Each station listed below has multiple activities and associated tent cards within it. *Optional*: Place the recommended book or a similar one at each station.

MATERIALS

- A read-aloud book, such as: *Blackout* by John Rocco
- *What Is a Scientist?* by Barbara Lehn
- LED flashlights (10)
- Wooden blocks of various shapes (10–15)
- Plastic animals (2–3)
- Outline cookie cutters (2–3)
- Dry-erase boards (6)
- 2–3 different transparent objects, such as clear plastic cups, take-out containers, or document covers
- 2–3 different translucent objects, such as wax paper, bubble wrap, or plastic milk jugs
- 2–3 different opaque objects, such as opaque plastic cups, wooden blocks, or cardboard
- 2–3 different reflective objects, such as metal spoons, mirrors, aluminum pie tins, CDs, or bike reflectors
- 2–3 different non-reflective objects, such as fabric pieces, cardboard, Styrofoam, or wooden spoons
- 3 colored cellophane squares—one in each color of red, yellow, blue
- Sheet of black construction paper
- Hand mirrors (2)
- Copy of **light** and **shadow** word cards
- Copy of hand shadow cards, printed on heavy cardstock (see Printable Resources)
- Copy of shadow challenge cards, printed on heavy cardstock (see Printable Resources)
- Copy of Translucent/Transparent/Opaque activity sheets (see Printable Resources)

BOOK CHOICES: Use one of the recommended read-aloud books above, or choose an alternate book that follows the guidelines on pp. 8–10.

Optional Additional Materials

- Additional objects that are translucent, transparent, opaque, and/or reflective
- Materials for propping up dry-erase boards, such as clay, books, or book stands
- Replacement batteries for flashlights
- Additional books about light and shadow (see Recommended Book List)
- Paper
- Crayons or markers
- Photo, book, or article about a person whose career involves light and shadow

Station 1. Explore with Light

Book connection: *Light: Shadows, Mirrors and Rainbows* by Natalie Rosinsky

Let It Shine: Gather the tent card, a flashlight, the transparent/translucent/opaque sorting sheets, and the examples of transparent, translucent, and opaque objects. Set out the objects all together and place the three sorting sheets in front of them.

Colors of Light: Gather a flashlight, a dry-erase board, the three colored cellophane sheets, and the tent card. Place the dry-erase board flat on the table with the cellophane sheets nearby.

Station 2. Reflecting Light

Book connection: *Shadows and Reflections* by Tana Hoban

Smooth, Flat, and Shiny: Set out a flashlight, the examples of reflective and non-reflective objects, and the tent card.

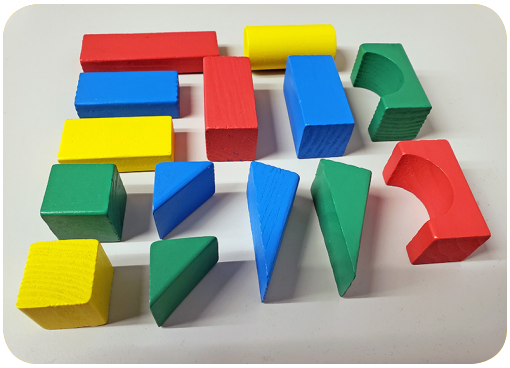
Bounce It, Bend It: Set out a flashlight, a hand mirror, a sheet of black construction paper, and the tent card.

Station 3. Changing Shadows

Book connection: *My Shadow* by Robert Louis Stevenson and Sara Sanchez

Moving Shadows: Gather a flashlight, a dry-erase board, 2–3 plastic animals, and the tent card. Prop the dry-erase board against a wall or bookcase or use another method to hold it upright as a surface for making shadows.

Changing Shapes: Set out a flashlight, the tent card, and three wooden blocks: a cylinder, a triangle, and a rectangle. Prop a dry-erase board against a wall or bookcase or use another method to hold it upright as a surface for making shadows.



Station 4. Shadow Play

Book connection: *The Dark, Dark Night* by M. Christina Butler

Make a Hand Shadow: Cut the sheets of hand shadow cards apart into individual cards. Set out a flashlight, a dry-erase board, the hand shadow cards, and the tent card. Prop a dry-erase board against a wall or bookcase or use another method to hold it upright as a surface for making shadows.

Shadow Challenge: Cut the sheets of shadow challenge cards apart into individual cards. Gather a flashlight, a dry-erase board, the shadow challenge cards, the wooden block shapes needed for the challenge (see photo), and the tent card. Prop the dry-erase board against a wall or bookcase or use another method to hold it upright as a surface for making shadows.

Station 5. Young Scientist

Book connection: *Flashlight* by Lizi Boyd

Bright, Dark: Set out a flashlight, 3–4 objects (such as blocks or plastic animals), and the tent cards.

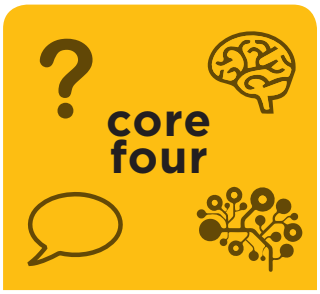
Station 6. Shadow Stories

Talk about Light and Shadow: Set out the tent card and a selection of books from the Recommended Book List near a seating area for family discussion.

Tell Your Story: Set out the tent card along with blank paper and crayons or markers on a table or other hard surface.

WELCOME (5 minutes)

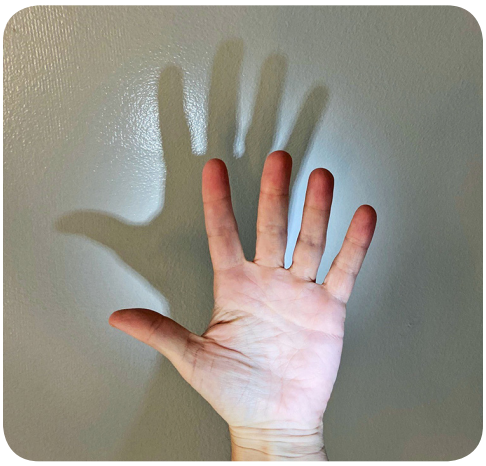
- Welcome families to the workshop. Introduce yourself to the participants.
- Explain that today's workshop was created by The Franklin Institute, a science museum in Philadelphia. The goals of the workshop are to have fun exploring light and shadow and to be scientists together.
- Set expectations for children's and caregivers' respective roles; for example: *Kids, you are the scientists today. Grown-ups, your job is to help your scientists—ask them questions, and let your children take the lead!*



Words in bold highlight Core Four strategies
(see pp. 5–7 for details)

ENGAGE: Light and Shadow (5 minutes)

- Introduce the **light** word card and invite the group to say the word aloud with you. If possible, place the card in a visible location, where families can refer to it throughout the workshop. **Make connections** to participants' everyday lives by asking about their experiences with light:
  - *Where have you seen lights before?*
  - *What different kinds of lights can you think of?*
  - *What is it like when the sun is shining, or when the light is on in a room?*
  - *What is it like when there is no light?*
- Shine a flashlight on the blank area of wall. **Encourage scientific thinking** by inviting the group to make observations and predictions.
  - *What do you see on the wall?*
  - *What do you think will happen if I turn the flashlight off? What if I turn it back on again?*
- Hold up your hand in front of the flashlight beam to create a shadow on the wall. **Ask questions** like:
  - *What do you see on the wall now?*
  - *What do you think you need to have to make a shadow? What makes you think that?*



- Introduce the **shadow** word card and invite the group to say the word with you. Place the card in a visible location for the rest of the session. Explain that **a shadow happens when light is shining on a surface and another object blocks the light**.
  - *Where have you seen a shadow before? What was it like?*
  - *What are some times or places where you can't see any shadows?*

- Turn your hand edgewise to the flashlight to create a long, thin shadow. **Encourage scientific thinking** by asking the group to observe and compare the shadow to the previous one.
  - *What does the shadow look like now?*
  - *How is it different from the shadow my hand made before?*
  - *Why do you think the shadow looks different, if my hand is the same shape?*
- Invite the group to look around the room (from where they are seated) to identify sources of light, and shadows where objects block some of their light. **Cultivate rich dialogue** by asking participants to describe their observations and predictions:
  - *Where do you see a shadow in this room? What does it look like?*
  - *What object do you think is making the shadow?*
  - *Where do you think the light is coming from that the object is blocking to make the shadow? What makes you think that?*

READ: Storytime (10 minutes)

- Transition to the storytime by explaining that you will now read a book to try to find out more about light and making shadows.
- Show the group the read-aloud book and introduce the title and author. **Encourage scientific thinking** by asking participants to make observations about the cover of the book and predictions about the story:
  - *What do you notice on the cover of this book?*
  - *What do you think this story might be about? What makes you think that?*
- Read the story, pausing to ask reflective questions. **Encourage scientific thinking** by inviting families to observe places in the story or illustrations where they notice lights and shadows and make predictions about what will happen next. **Ask questions** like:
  - *Where do you see shadows in this picture? What do you notice about their shapes?*
  - *Where do you think the light is coming from to make the shadow?*
  - *What object do you think is making the shadow? What makes you think that?*

- **Make connections** between the shadows in the book and the previous exploration:
  - *What shadows did we find here in this room?*
  - *How is that like what you see on this page? How is it different?*

EXPLORE: Activity Stations (30–40 minutes)

- Invite families to explore the activities at the stations, and encourage them to work together as adult-child pairs or groups. Explain that they are free to choose which stations to visit and to move between stations whenever they are ready. As families explore together, walk around to visit the stations and extend their learning.
- **Encourage scientific thinking** by inviting families to describe what they see, explain their thinking, or test a new idea:
  - *What do you notice about how that shadow is changing?*
  - *How can you change the shape of the shadow in a different way?*
- **Cultivate rich dialogue** by encouraging conversation between adults and children as they explore the activities. Invite adults to ask their children the questions on the tent cards or in the Question Guide. Ask children to describe to their adults what they are noticing, and what they plan to try next.
- **Make connections** by asking families to compare their observations to elements from the story or to their previous experiences:
  - *What things have you seen at home or at school that are transparent? What do you use them for?*
  - *How is the shadow you made like the one we saw in the story?*
  - *How is this shadow different from the one you made at the other station?*
- **Ask questions** like the ones below to more deeply engage families in the activities. Offer additional challenges, suggest new questions to investigate, or encourage them to find an alternate way to achieve their goal.

Let It Shine

Families test how different objects interact with light and sort them into the categories of transparent, translucent, and opaque.

- *Which category do you think each object belongs in? How can you tell?*
- *What other things have you seen before that might be transparent, translucent, or opaque?*

Colors of Light

Families explore color mixing by shining a flashlight through colored cellophane sheets.

- *What do you notice when you shine the flashlight through the red sheet?*
- *What do you think will happen if you shine it through all three sheets together?*

Smooth, Flat, and Shiny

Families investigate the properties of objects that allow them to reflect light.

- *What do you see when you shine the light on the spoon? How is that different from what you see with the aluminum foil?*
- *How does the reflection change if you shine the flashlight from the side instead of the top?*

Bounce It, Bend It

Families explore reflection by trying to "bounce" light to different locations using a mirror.

- *Where did you bounce the light to? How can you tell?*
- *How could you make the light end up on the ceiling? Where else can you make it go?*

Moving Shadows

Families use objects to create shadows and investigate how to make the shadows change size and location.

- *What do you notice about the shadow as you move the flashlight up and down?*
- *How could you make the shadow bigger by moving the animal instead of the flashlight?*

Changing Shapes

Families explore how the orientation of an object affects its shadow by making shadows with geometric blocks.

- *How could you make the cylinder and the rectangle have matching shadows?*
- *How many different shapes of shadows can you make with the triangle block?*

Make a Hand Shadow

Families create hand shadow shapes using example photos.

- *Which part of your hand do you think will make that part of the shadow? How can you tell?*
- *How could you change your hands to turn that shadow into something else?*

Shadow Challenge

Families use blocks to create shadows that match the ones pictured on challenge cards.

- *How do the triangles in your shadow look different from the ones in the picture?*
- *What could you change about that block to make its shadow look bigger?*

Bright, Dark

Families of young children explore the properties of light by shining flashlights on different objects and surfaces.

- *How does the animal look different when you shine the flashlight on it?*
- *What parts of the block do you think will be brightest if you shine the flashlight from the side?*

Shadow Stories

Families are invited to look at books, tell personal stories, and draw or write about their experiences with light and shadow.

REFLECT: Discussion (5 minutes)

- Gather the group and ask adults and children to reflect on their explorations. **Ask questions** like:
  - *What are some things you did today to explore light and shadows?*
  - *Did anything happen that surprised you? What was it?*
- **Make connections** between families' actions and scientific practices by referencing pages from the book *What Is a Scientist?* and asking them to share their own examples. **Ask questions** like:
  - *How were you like a scientist today?*
  - *When did you make a guess about something and test it?*
  - *Was there a time when you tried something over and over today?*
  - *Did you have fun?*
- If possible, share a photo, book, or article about a person whose career involves using or studying light. Look for examples of people who represent the gender, ethic, and cultural background of participating children and families.
- End by thanking the group for doing great work as scientists. **Encourage scientific thinking** by inviting them to continue noticing shadows of different shapes and sizes outside and at home.

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Light and Shadow Family Workshop Question Guide

Here are some key questions you can ask to guide children's explorations during the workshop.

WORKSHOP SECTION	ASK
ENGAGE: Lights and shadows in room Hand shadows	*What is it like when the light is on in a room?* *Where have you seen a* **shadow** *before? What was it like?* *Why do you think the two* **shadows** *of my hand looked so different if my hand is the same shape?*
READ: Storytime	*What do you notice on the cover of the book?* *What do you think will happen?* *Where do you see* **shadows** *in this picture?* *Where do you think the* **light** *is coming from to make the* **shadow***?*
EXPLORE: Light and Shadow station activities	*What other things have you seen before that might be transparent, translucent, or opaque?* *What do you think will happen if you shine the* **light** *through all three colored sheets together?* *How does the reflection change if you shine the flashlight from the side instead of the top?* *Where did you bounce the* **light** *to? How can you tell?* *How could you make the* **shadow** *bigger by moving the animal instead of the flashlight?* *How many shapes of* **shadow** *can you make with the triangle block?* *What else could you do to change the shape of the* **shadow***?*
REFLECT: Group discussion Read *What Is a Scientist?* Introduce a scientist	*What are some things you did to change a* **shadow's** *size or shape?* *Did anything happen that surprised you? What was it?* *How were you like a scientist today?*

To find out more about The Franklin Institute and Leap into Science, visit leap.fi.edu.

Recommended Book List

*Asch, Frank. (2000). *Moonbear's Shadow*. Aladdin Paperbacks. ISBN-13: 978-0689835193.

Berge, Claire; Alderman, Derrick; Shea, Denise. (2007). *Whose Shadow is This? A Look at Animal Shapes Round Long, And Pointy*. Picture Window Books. ISBN-13: 978-1404818231.

*Boyd, Lizi. (2014). *Flashlight*. Chronicle Books. ISBN-13: 978-1452118949.

Branley, Franklyn M. (1998). *Day Light, Night Light: Where Light Comes From (Let's-Read-and-Find-Out Science 2)*. HarperCollins. ISBN-13: 978-0064451710.

Butler, M. Christina and Chapman, Jane. (2008). *The Dark, Dark Night*. Good Books. ISBN-13: 978-1561486108.

Cobb, Vicki. (2002). *I See Myself*. Harper Collins Publishers. ISBN-13: 978-0688178369.

*Denos, Julia and Goodale, E.B. (2017). *Windows*. Candlewick Press. ISBN-13: 978-0763690359.

*Gal, Susan. (2009). *Night Lights.* Alfred A. Knopf, Random House Children's Books. ISBN-13: 978-0375858628.

Ginsburg, Mirra. (1991). *The Chinese Mirror*. Sandpiper. ISBN-13: 978-0152175085.

Graham, Joan Bransfield. (1999). *Flicker Flash*. Houghton Mifflin Books for Children. ISBN-13: 978-0618311026.

*Henkes, Kevin. (2004). *Kitten's First Full Moon*. Greenwillow Books. (7th Ed). ISBN-13: 978-0060588281.

*Henkes, Kevin. (2006). *La primera luna llena de Gatita*. Greenwillow Books, Tra edition. ISBN-13: 978-0060872236.

*Hoban, Tana. (1990). *Shadows and Reflections*. Greenwillow Books. ISBN-13: 978-0688070892.

Jacobs, Frank and Bursail, Henry. (2010). *Hand Shadow Fun*. Dover Books. ISBN-13: 978-0486796741.

Jonas, Ann. (1987). *Reflections*. Greenwillow Books. ISBN-13: 978-0688061401.

*Keats, Ezra Jack. (2000). *Dreams*. Puffin Books. ISBN-13: 978-3518112670.

*Rocco, John. (2011). *Blackout*. Hyperion Books. ISBN-13: 978-1423121909.

Rosinsky, Natalie. (2006). *Light: Shadows, Mirrors, and Rainbows*. Picture Window Books. ISBN-13: 978-1404803329.

Rosinsky, Natalie. (2007). *La Luz: Sombras, espejos y arco iris*. Picture Window Books. ISBN-13: 978-1404825031.

Recommended Book List

Tompert, Ann. (1988). *Nothing Sticks Like a Shadow*. HMH Books for Young Readers. ISBN-13: 978-0395479506.

Trumbauer, Lisa. (2004). *All About Light (Rookie Read-About Science)*. Children's Press, Scholastic Inc. ISBN-13: 978-0516258423.

Stevenson, Robert Louis and Sanchez, Sara. (2015). *My Shadow*. Sky Pony Press. ISBN-13: 978-1634501781.

Stevenson, Robert Louis and Sanchez, Sara. (2015). *My Shadow* (Chinese Edition). Shantou University Press. ISBN-13: 978-7565815188.

Yolen, Jane. (2009). *A Mirror to Nature: Poems about Reflection*. Wordsong. ISBN-13: 978-1590786246.

**Appropriate for early learners up to age five.*

Materials List

Right-hand columns indicate which workshops require the materials: Preschool (P), Elementary (E), Family (F). In cases where specific materials are not available, materials with a comparable purpose (such as other small objects for creating shadows) may be substituted.

REQUIRED MATERIALS	P	E	F
Dreams by Ezra Jack Keats	X		
Blackout by John Rocco		X	X
What Is a Scientist? by Barbara Lehn	X	X	X
LED flashlights with batteries (15)	X	X	X
8" x 11" dry-erase whiteboards (15)	X	X	X
Dry erase pens (15)		X	
100-pc. wooden block set, assorted shapes (1)	X	X	X
Outline-style cookie cutters, assorted shapes (at least 50)	X		X
Small plastic animals, assorted shapes (at least 50)	X		X
Hand mirror (1)			X
8" x 11" cellophane sheets—red, yellow, blue (1 each color, 3 total)			X
Reflective objects, such as metal spoons, aluminum pie tins, CDs, mirrors, or bike reflectors (2–3 items total)			X
Non-reflective objects, such as wooden spoons, cardboard, construction paper, or Styrofoam (2–3 items total)			X
Transparent objects, such as clear plastic cups, takeout containers, or document covers (2–3 items total)			X
Translucent objects, such as wax paper, bubble wrap, or translucent plastic cups (2–3 items total)			X
Opaque objects, such as cardboard, felt, or opaque plastic cups (2–3 items total)			X
Black or dark-colored construction paper (1 sheet)			X
Shadow challenge cards, printed on heavy cardstock or laminated+		X	X
Tent cards, printed on heavy cardstock+			X
Translucent/Transparent/Opaque sorting cards, printed on heavy cardstock or laminated+			X

(continued on next page)

+See Printable Resources section

Hand shadow cards, printed on heavy cardstock or laminated+			X
Light word card, printed on heavy cardstock+	X	X	X
Shadow word card, printed on heavy cardstock+	X	X	X

OPTIONAL ADDITIONAL MATERIALS	**P**	**E**	**F**
Large sheet of blank paper, such as chart paper	X	X	X
Bins or buckets for holding shadow objects	X	X	
Replacement batteries for flashlights	X	X	X
Additional objects that create interesting shadows, such as whisks, colanders, translucent objects, etc.	X		X
Additional examples of reflective and non-reflective objects			X
Additional examples of translucent, transparent, and opaque objects			X
Materials for propping up dry-erase boards, such as clay or book stands	X	X	X
Blank drawing paper	X	X	X
Crayons or markers	X	X	X
Photo, book, or article about a person whose career involves light and shadow	X	X	X
Additional light and shadow books (see Recommended Book List)	X	X	X

+See Printable Resources section

Standards Alignment

NEXT GENERATION SCIENCE STANDARDS

Disciplinary Core Ideas:

- PS4.B, Electromagnetic Radiation: *Objects can be seen if light is available to illuminate them or if they give off their own light. Some materials allow light to pass through them, others allow only some light through and others block all the light and create a dark shadow on any surface beyond them, where the light cannot reach. Mirrors can be used to redirect a light beam.*

Science and Engineering Practices:

- Asking Questions and Defining Problems
- Planning and Carrying Out Investigations
- Analyzing and Interpreting Data
- Constructing Explanations and Designing Solutions
- Engaging in an Argument from Evidence

Crosscutting Concepts:

- Patterns: *Patterns can be observed and used to make predictions.*
- Cause and Effect: *Tests can gather evidence about cause-and-effect relationships.*
- Systems and System Models: *Systems in the natural and designed world have parts that work together. Systems may be stable under some sets of conditions and change under others.*

COMMON CORE STATE STANDARDS

English Language Arts Standards:

- CCSS.ELA-Literacy.SL.K-5.1: *Engage in collaborative conversations with diverse partners about age-appropriate topics.*
- CCSS.ELA-Literacy.L.K-5.5: *With guidance and support from adults, explore word relationships and nuances in word meanings.*
- CCSS.ELA-Literacy.L.K-5.6: *Use words and phrases acquired through conversations, reading and being read to, and responding to texts.*

la luz

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light

la sombra

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shadow

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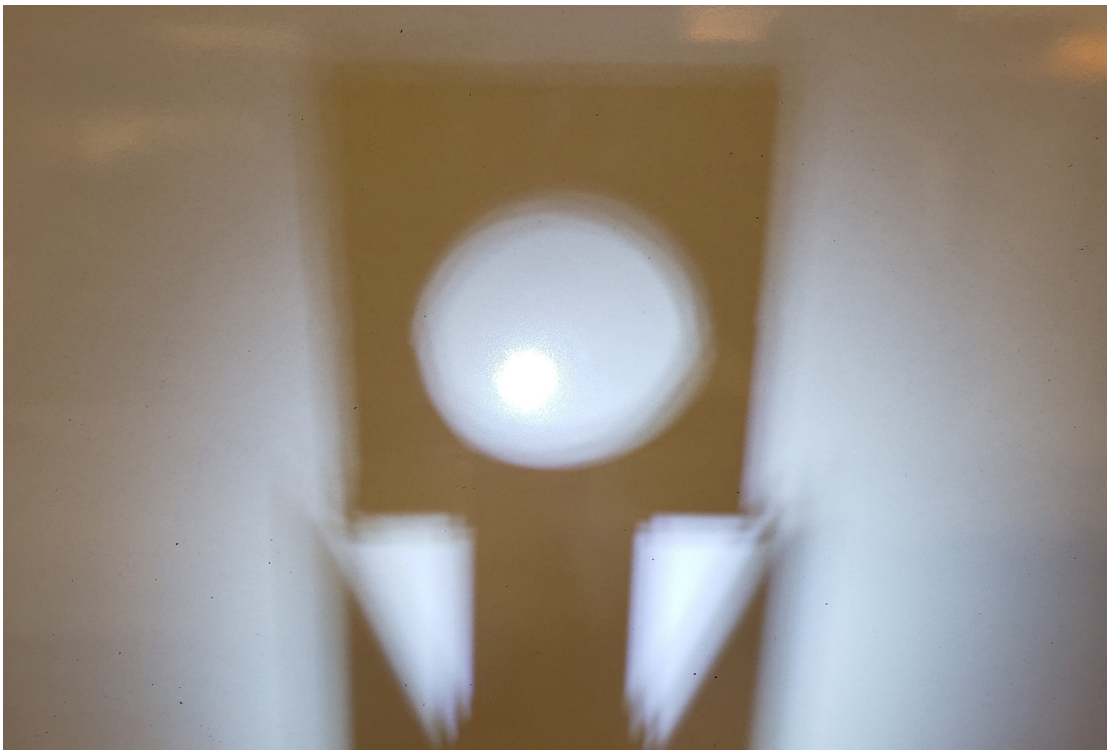

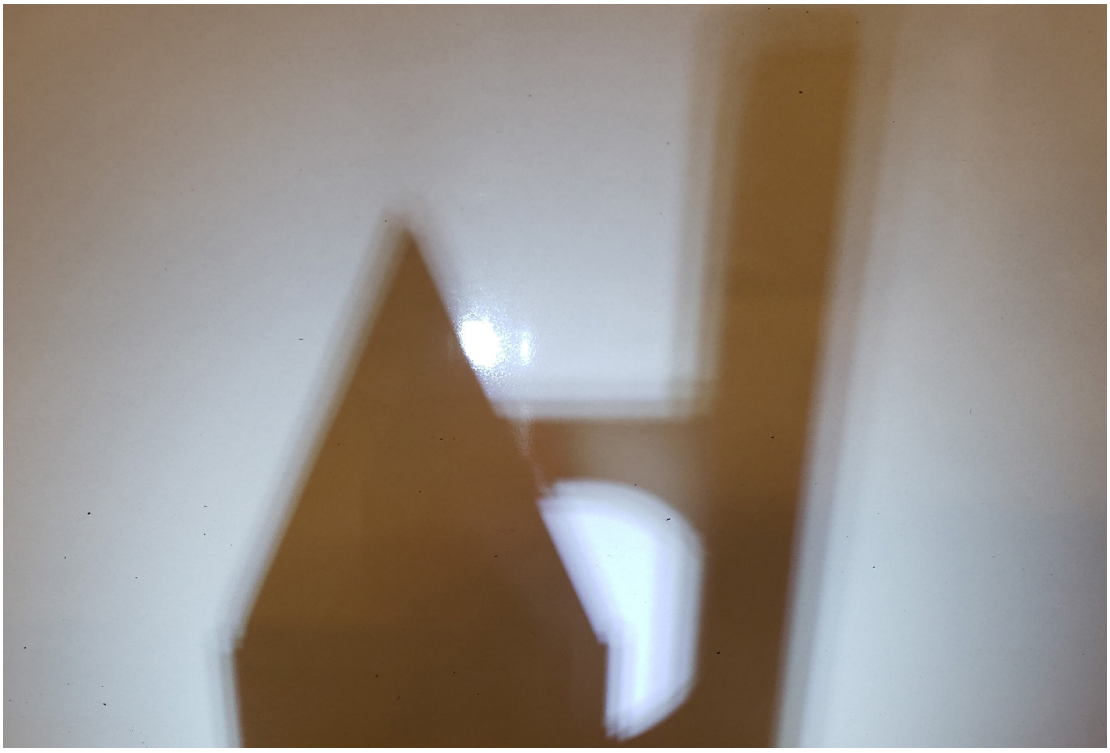

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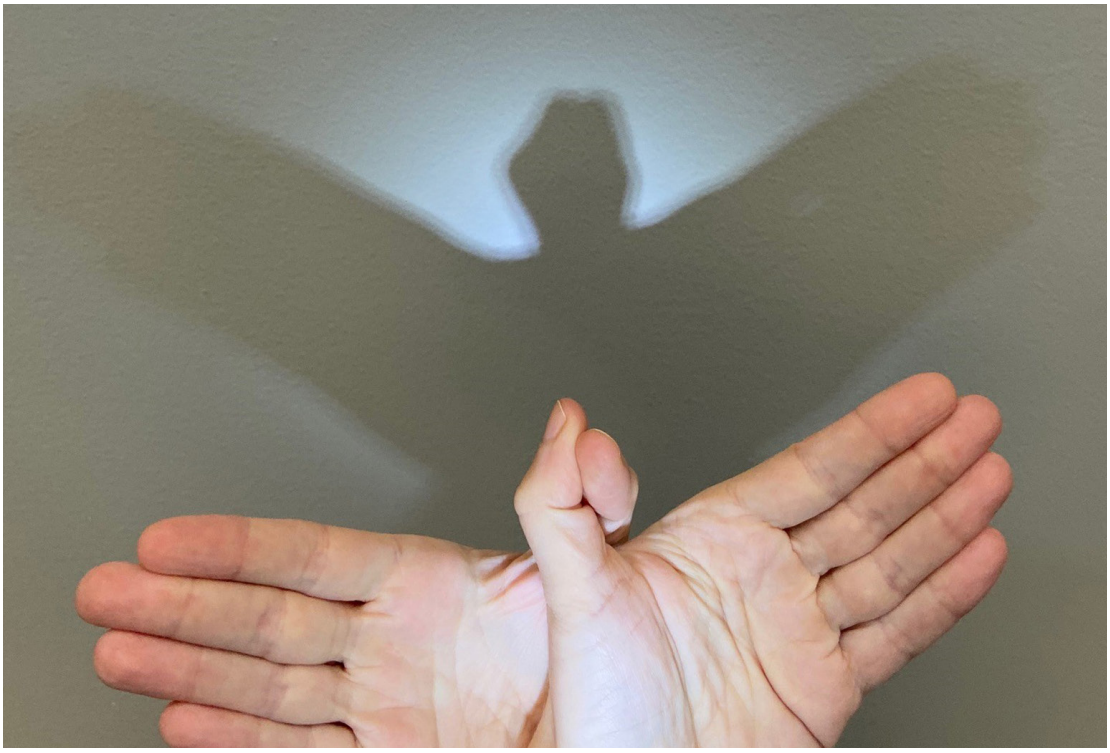

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Transparent Materials
Materiales Transparentes

Place objects here if they allow all the light to pass through unchanged.
Coloca los objetos aquí si permiten que toda la luz pase sin cambios.

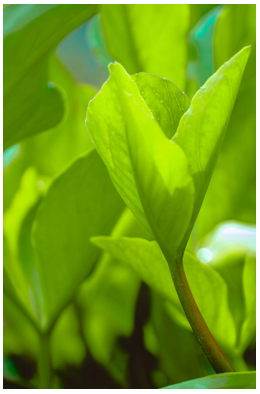
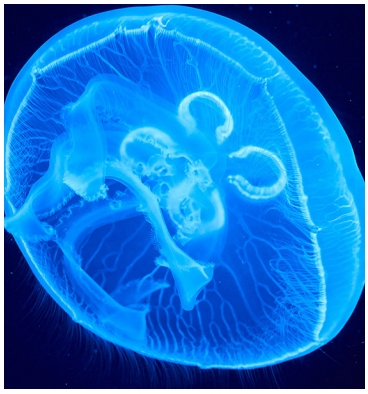




Translucent Materials
Materiales Translúcidos

Place objects here if they allow some light to pass through, but the light is changed or dimmer.
Coloca los objetos aquí si permiten que parte de la luz pase, pero la luz cambia o se atenúa.



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Opaque Materials
Materiales Opacos

Place objects here if they block or absorb all the light.
Coloca los objetos aquí si bloquean o absorben toda la luz.

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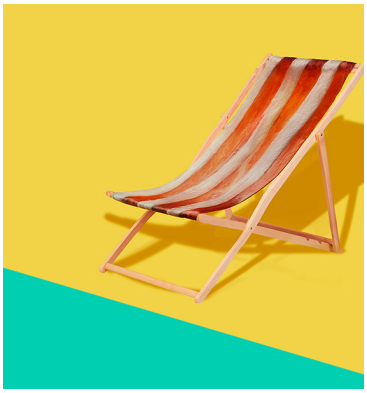

Estación 1:
Explora con la luz

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Station 1:
Explore with Light

Alumbra cada material con la linterna.

¿Cuánta luz atraviesa el material?

Decide si el material es **transparente**, **translúcido** u **opaco** según la cantidad de luz que lo atraviesa.

Déjala brillar

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Let It Shine

Shine the flashlight through each material.

How much of the light passes through?

Decide if the material is **transparent**, **translucent**, or **opaque** based on how much light passes through.

Colores de la luz

Alumbra la superficie blanca con la linterna. Sostiene una hoja de color delante de la luz.

¿Qué observas?

¿Cómo podrías formar una luz verde o púrpura?

FOLD HERE

Colors of Light

Shine the flashlight at the white surface. Hold a colored sheet in front of the light.

What do you notice?

How could you make green or purple light?

Estación 2:
Reflejar la luz

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Station 2:
Reflecting Light

Alumbra cada uno de los objetos con una luz.

Observa cómo cada material refleja la luz de distintas maneras.

¿Qué objetos son mejores para verte?

¿Qué tienen en común estos objetos?

Liso, plano y brillante

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Smooth, Flat, and Shiny

Shine a light on each of the objects.

Notice how each material reflects light in different ways.

Which objects work best for seeing yourself?

What do these items have in common?

Trabaja con un compañero para hacer rebotar la luz en el espejo y doblar hacia el papel negro. Mueve la linterna o el espejo de diferentes maneras para lograrlo.

¿Cómo puedes saber cuando la luz está tocando el papel?

¿En qué otra cosa puedes hacer rebotar la luz?

Hazla rebotar y doblar

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Bounce It, Bend It

Work with a partner to bounce light off the mirror and onto the black paper. Move the flashlight or the mirror in different ways to get it right.

How can you tell when the light is hitting the paper?

What else can you bounce the light onto?

Estación 3:
Cambiar las sombras

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Station 3:
Changing Shadows

Haz una sombra con uno de los objetos.
Busca maneras de mover y cambiar
la sombra.

¿Puedes hacer que la sombra se mueva hacia arriba, hacia abajo o hacia un lado?

¿Cómo puedes hacer que la sombra se agrande o se achique?

Mover las sombras

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Moving Shadows

Make a shadow with one of the objects. Find ways to move and change the shadow.

Can you make the shadow move up, down, or sideways?

How could you make the shadow grow bigger or smaller?

Haz una sombra con uno de los bloques. Compara la forma de la sombra con la forma del bloque.

¿Puedes hacer una sombra rectangular usando un bloque triangular?

¿Cuántas formas de sombras diferentes puedes formar con cada bloque?

Cambiar formas

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Changing Shapes

Make a shadow with one of the blocks. Compare the shadow's shape to the block's shape.

Can you make a rectangle shadow using a triangle block?

How many different shadow shapes can you make from each block?

Estación 4:
Teatro de sombras

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Station 4:
Shadow Play

Elije tu sombra chinesca favorita de las cartas. Trabaja con un compañero para hacer esa sombra.

¿Cómo puedes mover tus manos para hacer la sombra de un animal diferente?

¿Qué otras formas de sombra puedes crear con tus manos?

Haz una sombra chinesca

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Make a Hand Shadow

Choose your favorite hand shadow from the cards. Work with a partner to make that shadow.

How can you move your hands to make a different animal-shaped shadow?

What other shadow shapes can you create with your hands?

Elije una imagen de sombra de desafío.

Usa los bloques para hacer una forma cuya sombra coincida con la imagen.

¿La forma de tu bloque coincide con la forma y el tamaño de la imagen?

¿Qué otras formas de sombra puedes hacer con estos bloques?

Desafío de sombras

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Shadow Challenge

Pick a shadow challenge picture.

Use the blocks to make a shape whose shadow matches the picture.

Does your block's shape match the picture's shape and size?

What other shadow shapes can you make from these blocks?

Estación 5:
Joven científico

(Ideal para niños de 3 a 5 años)

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Station 5:
Young Scientist

(Best suited for children ages 3–5)

Alumbra distintos objetos con la linterna. Observa cómo los objetos cambian a la luz.

¿Qué partes del objeto están iluminadas? ¿Qué partes están oscuras?

¿Cómo podrías cambiar las partes que están iluminadas y las partes que están oscuras?

Brillante, oscuro

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Bright, Dark

Shine the flashlight on different objects. Notice how they change in the light.

Which parts of the object are bright? Which parts are dark?

How could you change which parts are bright and which parts are dark?

Estación 6:
Historias de sombras

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Station 6:
Shadow Stories

Use these books to talk together and tell stories about light and shadow.

Where do you see lights, reflections, or shadows in the books?

What other stories about light and shadow do these books make you think of?

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Habla sobre la luz y la sombra

Usa estos libros para hablar juntos y contar historias sobre la luz y la sombra.

¿Dónde ves luces, reflejos o sombras en los libros?

¿En qué otras historias sobre la luz y la sombra te hacen pensar estos libros?

Comparte tus propias historias sobre la luz y la sombra contándoselas a un compañero, haciendo un dibujo o escribiendo una canción, un poema o un cuento.

¿Cuál es tu historia favorita sobre la luz o la sombra?

¿Qué historia puedes contar acerca de lo que hiciste hoy?

Cuenta tu historia

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Tell Your Story

Share your own stories about light and shadow by telling a partner, drawing a picture, or writing a song, poem, or story.

What is your favorite story about light or shadows?

What story can you tell about what you did with light and shadows today?