



FACILITATOR GUIDE

Bear's Shadow

Learning objectives

This activity explores these ideas:

- A shadow is created when an object blocks light from falling on a surface.
- An object's shadow always appears on the opposite side from the light source.
- Shadows change when the relative positions of the light source and the object change.

The activity can also be connected to the 2024 solar eclipse event, with the following additional learning objective:

- A *solar eclipse* occurs when the Moon passes directly between the Sun and the Earth, blocking the Sun's light and casting a shadow on Earth.

Materials

- Flashlight "sun"
- Toy bear
- Toy tree
- Landscape mat with pond and fish
- Challenge cards
- Bear's Shadow information sheet
- Moon's Shadow information sheet
- Activity and facilitator guides
- Optional: *Moonbear's Shadow* storybook by Frank Asch

The Explore Science toolkit comes complete with all necessary materials for this activity. Materials are also readily available to create or restock activity kits. Graphic files (including the landscape mat) can be downloaded from www.nisenet.org. The toy bear is available through www.learningresources.com. The sun and tree toys in this activity can be bulk ordered through qualitylogoproduct.com. The squishy sun toy has been modified to fit onto a small LED flashlight (available at discount stores). *Moonbear's Shadow* by Frank Asch can be ordered from online booksellers, or found in bookstores or your local library.

Safety

Remind participants not to shine the flashlight in anyone's eyes. Do not allow a child to place the toys in his or her mouth, and clean the toys promptly and appropriately if they come into contact with a

child's mouth. Replace the soft toys if they begin to fall apart, so that broken pieces do not present a choking hazard.

Notes to the presenter

The concepts in this activity are appropriate for all ages. This activity is designed to appeal to preschool-aged visitors, as well as accompanying adults and older children.

When doing this activity, encourage participants to switch the flashlight on and off, and use it to make a shadow of the toy bear. Then, have them experiment moving the light, the toy bear, and the tree to recreate scenes on the challenge cards:

- Move the Sun across the sky, from sunrise to sunset. What happens to Bear's shadow as the Sun moves?
- Shine the light straight down on Bear from above his head. Where is his shadow?
- Try to make Bear's shadow appear in front of him and behind him.
- Try to make Bear's shadow longer and shorter.
- Bear wants to hide in the shade of the tree. Can you help him?
- Try to make Bear's shadow touch the fish in the pond. (In the story, Bear's shadow scares the big fish away.)

This activity allows children to **model** the way the Sun casts shadows outside. Use the question prompts on the challenge cards to help children investigate how changing the flashlight's position changes the size, length, and position of shadows. As children test different positions of the flashlight, ask them to **compare their observations**. Encourage them to use their observations to **make claims** about how to make the shadows longer or shorter (or in front of or behind) the toy bear. Children can make claims either verbally or by demonstrating with their model.

The context and illustrations for the activity come from the book *Moonbear's Shadow* by Frank Asch. You can make the book available for groups to browse before or after they try the activity.

Optional extensions

If you can take children outside on a sunny day or easily darken the room you're in, you can make a connection between Bear's shadow and the children's own shadows. Reinforce the learning goals in this activity by explaining that the Sun, light bulbs, and flashlights are all examples of sources of light. When an object blocks the path of light, that object can cast a shadow. We can see the shadow on surfaces such as floors or walls.

You might also experiment with offering this activity as part of a structured story-time program. You could read *Moonbear's Shadow* by Frank Asch and then offer several extra sets of materials to allow multiple groups of children to experiment with the activity.

Optional connection to the 2024 Solar Eclipse

The next total solar eclipse to be visible in North America happens on April 8th, 2024. In the United States, the path of totality—where the entire sun will be blocked—will stretch from Texas to Maine.

You can connect the learning in Bear's Shadow activity to the solar eclipse event, using the Moon's Shadow information sheet. The concepts in this optional connection are most appropriate for slightly older children and adults.

During a solar eclipse, Earth's moon orbits between the sun and Earth and blocks the sun's light. When the moon is lined up just right between the sun and Earth it casts a shadow, and when that shadow falls onto Earth we see a solar eclipse. During a solar eclipse, Earth's Moon orbits between the Sun and Earth and blocks the Sun's light. When the Moon is lined up just right between the Sun and Earth it casts a shadow, and when that shadow falls on Earth we see a solar eclipse.

Difficult concepts

In the book *Moonbear's Shadow*, Bear's shadow disappears at noon. The assumption in the story is that the Sun is directly overhead, and thus Bear's shadow is directly underneath him. This phenomenon can occur, but only in certain places at certain times. At the equator, the Sun will be directly overhead at noon on the equinoxes (around March 20 and September 22 each year). At other locations, such as within the tropics, when this phenomenon occurs varies depending on the latitude. In the continental United States, which is not within the tropics, solar noon is when our shadows are at their shortest, but they will never completely disappear.

Light and shadows can be tricky concepts. Listen to responses or watch for interactions with guests that might indicate they are having a difficult time understanding. Remember:

- Light travels in straight lines from the source to the object (technically light travels in waves, but participants may assume straight lines when it comes to making shadows).
- Shadows are 3D and occur from the back of the object (the non-lit side) through space to another surface.
- Phases of the Moon are also shadow related, but different from an eclipse where a third object (Earth or the Moon) blocks the light from the Sun.
- We see the Moon because it reflects light from the Sun, not because it makes its own light.
- It is always dangerous to look directly at the Sun.

Staff training resources

Refer to the *Tips for Leading Hands-on Activities* sheet in your activity materials.

- An activity training video is available at vimeo.com/191168902.
- A content training video is available at vimeo.com/191171377.

The NISE Network has a curated list of programs, media, and professional development resources in the NASA Wavelength Digital Library that directly relate to the toolkit. These resources can be viewed and downloaded from nasawavelength.org/users/nisenet.

Credits and rights

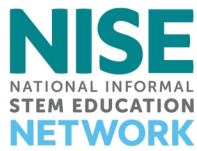
This activity is adapted from Bear's Shadow, developed by The Astronomical Society of the Pacific. Retrieved from: <https://www.astrosociety.org/wp-content/uploads/2015/05/BearsShadow.pdf>

Bear's Shadow illustrations are courtesy Frank Asch, from the book *Moonbear's Shadow*. They have been reproduced with permission from the artist. The artist retains all copyright to these images. <http://frankasch.com/>

Box shadow, shadow puppet, eclipse geometry, glasses, and path of totality illustrations by Emily Maletz for the NISE Network.

Eclipse photograph taken on Wolei Island courtesy the Exploratorium. Used with permission.

Stock images of child and tree shadows used under license from iStock.com. Stock images are not covered under the terms of Creative Commons.



Developed and distributed by the National Informal STEM Education Network.

Copyright 2016, Science Museum of Minnesota. Published under a Creative Commons Attribution-Noncommercial-ShareAlike license:

<http://creativecommons.org/licenses/by-nc-sa/3.0/us/>

This material is based upon work supported by NASA under cooperative agreement award number NNX16AC67A. Any opinions, findings, and conclusions or recommendations expressed in this material are those of the author(s) and do not necessarily reflect the view of the National Aeronautics and Space Administration (NASA).



EXPLORING EARTH

Bear's Shadow

Try this!



Let's pretend the flashlight is the Sun and use it to learn about shadows! Shine the Sun onto the toy bear. Where is Bear's shadow?



Try moving the light. What happens to Bear's shadow as the Sun moves?



In *Moonbear's Shadow*, Bear discovers his shadow and has many other adventures. Choose a challenge card and try new things with Sun and Bear!

A shadow is created when an object blocks light from falling on a surface.

An object's shadow always appears on the side opposite the light source. In this activity, Bear's shadow appears on the mat when light from the flashlight is blocked by the toy bear. No matter what he does, Bear is always between the Sun and his shadow!

The flashlight in this activity is a model for how the Sun casts shadows on Earth. On a sunny day, you can block sunlight and cast a shadow on the ground, a wall, or another surface. Your shadow always falls on the side opposite from the Sun, just like Bear's. If the Sun is behind you, your shadow will be in front of you.



To make a shadow, you need a source of light, an object to block the light, and a surface for the shadow to fall upon.

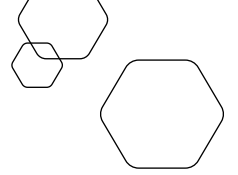
When the light source or the object moves, the shadow changes. If you hold the flashlight down low, close to the table, Bear's shadow gets very long. If you move the light high over Bear's head, his shadow gets shorter.



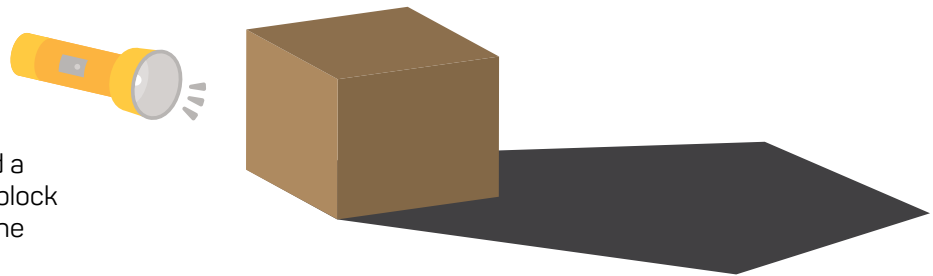
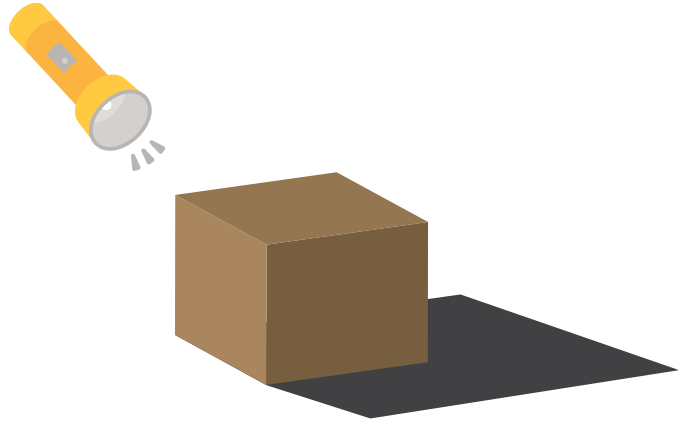
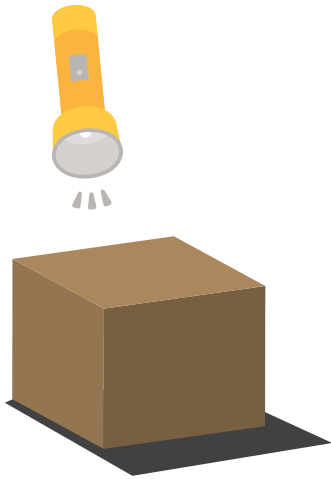
Shadows are longer in the early morning and late evening, when the Sun is low on the horizon.

Outside, shadows change throughout the day as the Sun appears to move in an arc across the sky. A tree's shadow is longer at sunrise and sunset, when the Sun appears low in the sky, and shorter at noon when the sun appears high in the sky.

Bear's Shadow



Bear makes a shadow on the mat when he blocks the light of the flashlight. When you're outside, you make a shadow on the ground when you block the light from the Sun. In fact, anything that blocks a source of light can make a shadow!



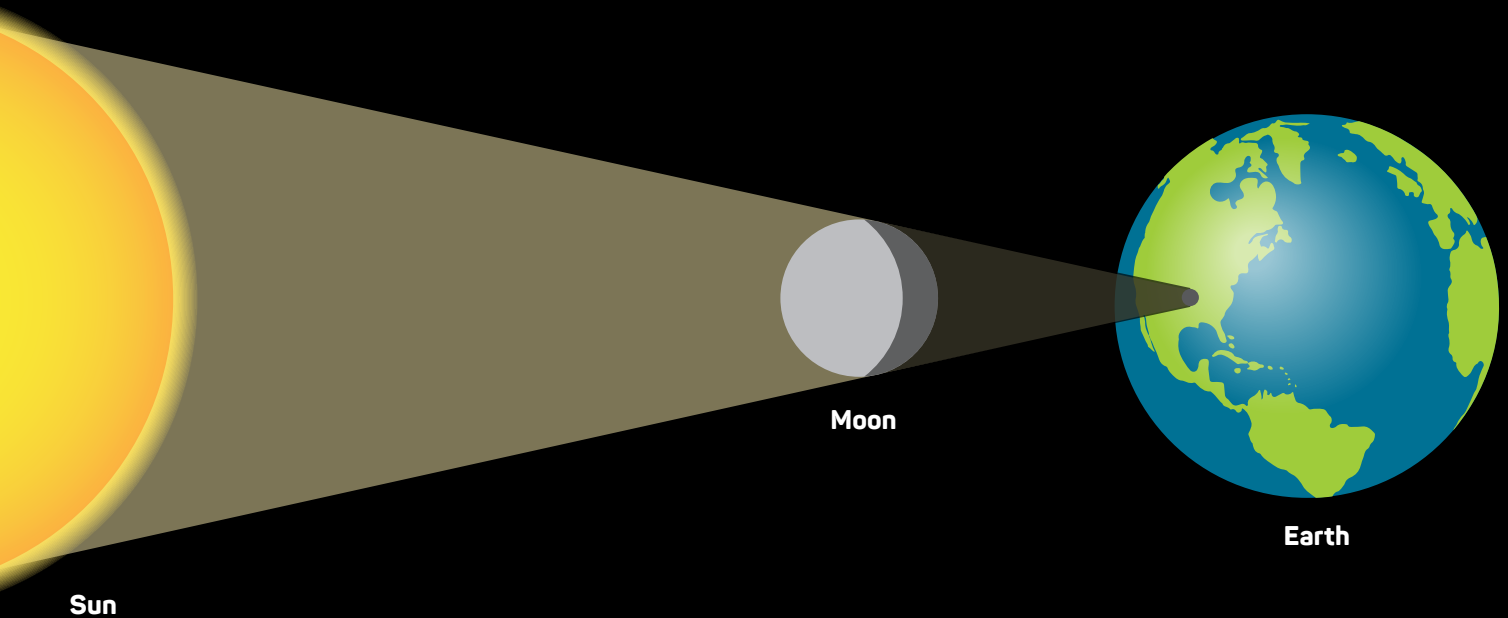
To make a shadow, you need a source of light, an object to block the light, and a surface for the shadow to fall upon.



Shadows can be fun! Can you see the shadow goat in this picture? What shapes can you make by blocking light with your fingers?

Moon's Shadow

The Moon makes a shadow on Earth when it blocks the light of the Sun.



During a solar eclipse, the Moon is in between the Sun and Earth. It blocks the light of the Sun and creates a shadow on Earth.

Image not to scale

Earth is always moving in a circle around the Sun, making a complete orbit every year.

The Moon is always moving in a circle around Earth, making a complete orbit about once a month. Every once in a while, the Sun, the Moon, and Earth line up just right and the Moon briefly casts a shadow on Earth. We call this rare event a *solar eclipse*. People who are in the area of the Moon's shadow can experience surprising things. The sky gets dark, the temperature drops, and the Sun momentarily disappears.