Light that Does Not Pass (Shadows)

You are relaxing with a book on a nice sunny day when a friend leans over your shoulder and the page goes dark. "Hey, you're blocking my light!" It is a familiar experience. Any time an object blocks the light from another source, it forms a shadow. Here on Earth, shadows come from lights in a room, street lamps, flashlights, and the Sun. In our solar system, the Sun is the major natural source of visible light, and it creates all kinds of shadows on the Moon, on the Earth, and on other planets.

Activity 1 – ***Shifty Shadow Shapes!***

Core concept: The shape of a shadow can change given the orientation of the light or the object blocking the light. This activity explores shadows cast by various shaped objects and those cast by light sources at different angles.

Exhibit connections: Shadows, panel 1 - shadows of people on a beach, panel 3 - a moon of Jupiter

Materials: Adjustable light, block stands, solid screen, translucent screen, wooden shapes, image of shadows of people on a beach, images of Jupiter moon and shadow, and image of shadow of Curiosity Rover on Mars

Background:
Shadows are our ever-constant companion. They are created when an object obstructs (absorbs or reflects) light from a light source, creating a region behind the object where light cannot reach. The size and shape of a shadow changes when the orientation of the object or the light source is changed. When the light source is directly above the object (like the sun overhead in the sky) a shadow cast will be short. However when the light source is at an angle to the object, the shadow will be long.

Misconception alert:
Young children especially have difficulty understanding that light travels in straight lines from a source, and that shadows are the result of an object blocking light from passing straight through. They may think that they can only have one shadow, and when asked to draw a picture showing how shadows form, they rarely include a light source. Adults are often surprised by the idea that shadows can be cast in space. You can use these activities to help visitors identify the relationships between a light source, the path light travels, and objects that may block or reflect light from the source, whether they are on Earth or in space.

Suggestions for introducing the activity:
Ask visitors to look for their shadows. What in the room is causing the shadow? Are the edges of your shadow crisp or blurry? What would happen if there was just one light in the room, or if you were standing outside? This introduces the concept that shadows occur when an object blocks light, and the number of shadows depends on the number of light sources being blocked!

Procedure:
Set up the adjustable lamp so the light shines directly on the center of the solid screen (approximately half-way up the shaft). Ask one visitor to choose a wooden shape and use it to make a shadow on the solid screen. Explore the shapes the shadow makes as the orientation of the shape is changed. For example, what happens to the ring if it is held edge on toward the screen?

Observe the shadow of the rectangle. Now move the light to the bottom of the shaft. What happens to the shadow? Now slide the light to the top of the shaft. What happens to the shadow?

Discussion/Questions for visitors to consider:
What happens to other shapes when the light is shone at different angles? Ask visitors to look at the image of the shadows of people on a beach. Where do they think the sun was positioned in the sky when the picture was taken? That is, what time of day was it when this image was created? Now have visitors look at the images of Jupiter's moon and of Curiosity's shadow on the Mars landscape. What is the light source? Where is the light source?

Next, change the solid screen to the translucent screen. Ask a visitor to choose another wooden shape, and place it on the lighted side of the translucent screen. Encourage other visitors to stand behind the screen so they cannot see the actual object and to guess the shape of that object just by observing the shadows. Are there any shapes that always look the same no matter how they are oriented?

Activity 2 – *Phases, Eclipses, and Shadows, Oh My!*

Core concepts: phases of the moon, conditions needed for lunar and solar eclipses. These activities explore shadows in space.

Exhibit connections: Shadows panel 2 - the shadow of the earth on the moon during a lunar eclipse, panel 3 - the shadow of one of Jupiter's moons on its surface.

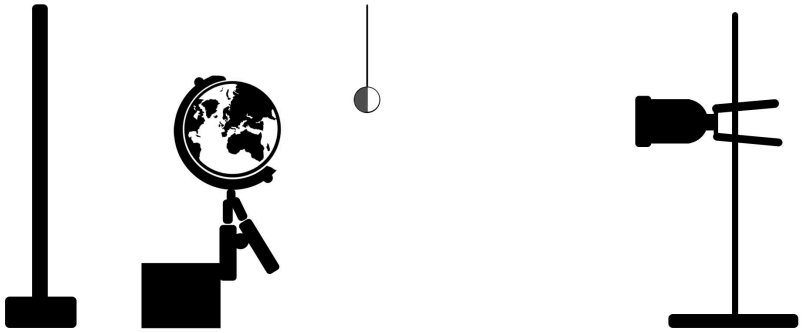
Materials: Adjustable light, Earth globe, moon on a stick, images of an eclipse, image of shadow cast by a moon onto Jupiter, image of moon phases, image of shadow of the moon cast on Earth during solar eclipse

Background:
Many people wonder why the moon goes through phases, or what conditions need to exist for an eclipse to occur. Some simple experiments with shadows can illuminate quite a bit! The moon goes through phases because the Sun only illuminates certain parts of the Moon on its trip around the Earth from our perspective. On the other hand, lunar eclipses occur when the Earth blocks the Sun's light from falling on the moon, creating a shadow.

Misconception Alert:
A very prevalent misconception, among children and adults alike, is that the phases of the moon are caused by the shadow of the Earth blocking the Sun's light from falling on the moon. When facilitating these activities, take special care to distinguish between relatively rare *eclipse* situations, which DO involve the shadow of one object (the Earth or Moon) blocking the light shining on the other from the Sun; and phases, which do NOT involve a 3rd object casting a shadow!

Suggestions for introducing the activity:
Explore visitors' ideas about the moon. Does it always look the same? Is it visible every night? Why does the moon go through phases? What causes an eclipse? A simple model can be used to explore all of these ideas!

Procedure:
To demonstrate moon phases –
Use the same light and screen set-up as the first activity.
Get the room as dark as possible. If not possible, place a black screen on either side of the area between the light source and the opaque white screen. Clip the Earth globe into a holder using an orange clip. Place the Earth between the light ("the Sun") and the screen. Turn on the Sun and revolve the moon on a stick around the Earth. Observe what parts of the "Moon" are illuminated when it's at different angles compared to the "Sun."



To demonstrate a lunar eclipse –
Have a volunteer come up and point out their hometown on the globe. Ask the volunteer to try to adjust the lamp position and hold the moon so that the moon appears in the earth's shadow from the perspective of someone standing on that place on the globe.

To demonstrate a solar eclipse –
Now ask the volunteer to try to adjust the moon and lamp so that a shadow of the moon falls on the earth at her hometown. People living within this shadow would see a solar eclipse!

(Note: Be sure to point out the difference between a typical New Moon phase that does NOT involve the Moon casting a shadow on the Earth, and a solar eclipse, where the moon is in perfect alignment with the sun so that it DOES cast a shadow on the Earth. You may need to point out that because this model is not to scale, a much larger area of Earth experiences a solar eclipse (being in the moon's shadow) than in real life. Also, this not-to-scale model makes it much more likely for the moon to be in the Earth's shadow (a lunar eclipse) during the full-moon phase in than is true in the geometry of the vast Earth-Moon-Sun system.)

Discussion/Questions for visitors to consider:
Moon phases -- What does the Moon look like at different points around its orbit? Where is the moon full? Where is it new? Is the moon always the same brightness? What parts of the moon are lit up by the model Sun? Is this a shadow or just the moon being illuminated differently from different perspectives? Show visitors the image of the Moon at different phases. Can they recreate the different phases using the Earth globe and model of the moon?

Eclipse -- Will all parts of the world see a lunar eclipse at the same time? How about a solar eclipse? Why is seeing a solar eclipse from a particular location such a rare event? Check out the image from the Mir spacecraft that shows the shadow of the Moon on the Earth. That's exactly what you just re-created!