National Aeronautics and Space Administration

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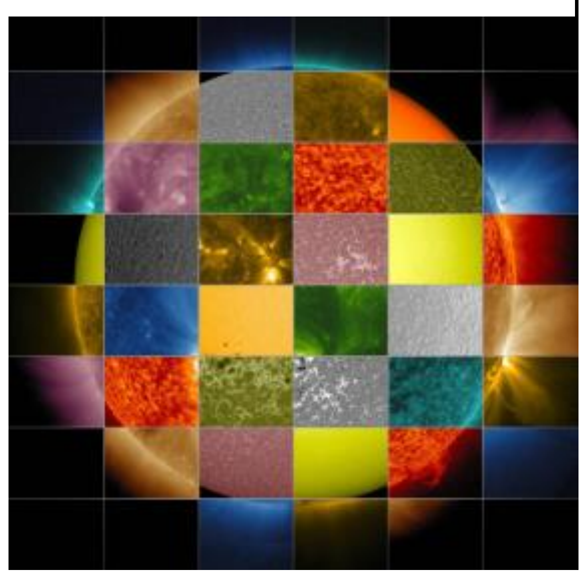
Guide Lites

Interactive Lesson: Solar Images



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National Education Standards
Next Generation Science Standards (NGSS)

- ESS1-1. Earth's Place in the Universe
  - 1-ESS1-1: Use observations of the sun, moon, and stars to describe patterns that can be predicted.
  - MS-ESS1-1: Develop and use a model of the Earth-Sun-Moon system to describe the cyclic patterns of lunar phases, eclipses of the sun and moon, and seasons.
- ESS1.A: The Universe and its Stars
  - Patterns of the motion of the sun, moon, and stars in the sky can be observed, described, and predicted.
- ESS1.B: Earth and the Solar System
  - The model of the solar system can explain eclipses of the sun and the moon.
- SEP2: Developing and using models to describe phenomena
- CCC -- Patterns: Patterns can be used to identify cause-and-effect relationships.

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Solar Images

While sunlight fundamentally enables and sustains life, our star also produces radiation and magnetic energy that can disrupt planets' atmospheres, our satellites, and even life. NASA's Heliophysics Division studies the sun in order to better understand why it is so dynamic and how its constant radiation affects the space around it, Earth, and all the planets. Such information helps us better protect our technology and astronauts as our journey to explore takes us further and further from home. To learn more about NASA Heliophysics, visit: https://science.nasa.gov/heliophysics

Fun Fact:
It takes about 8 minutes for light from the sun to reach Earth.

Specialized instruments, in telescopes such as NASA's Solar Dynamics Observatory (SDO), NASA's Solar Terrestrial Relations Observatory (STEREO) and the ESA/NASA Solar and Heliospheric Observatory (SOHO), observe sunlight far beyond the **wavelengths** within visible light. Different wavelengths reveal different parts of the sun with different temperatures. Visible light with a yellow-green filter is effective for looking at the ***photosphere***, or surface of the sun. The **chromosphere** is seen in UV light. Very hot regions of the ***corona*** and **solar flares** are visible in extreme UV light. For more information about the various wavelengths within the electromagnetic spectrum, explore this online activity found at NASA Space Place, https://spaceplace.nasa.gov/magic-windows/en/

Total solar eclipses are rare and happen only when the sun, moon and Earth line up so that the moon blocks all of the sun's light to part of Earth's surface. When aligned perfectly, the moon and the sun both appear to be about the same size from the viewer's position on Earth. The sun is about 400 times wider than the moon, but it is also about 400 times farther away. That geometry means that when they line up, just right, the moon blocks the sun's entire surface, creating a total solar eclipse. Total solar eclipses happen only during new moon phases, when the moon passes directly between Earth and the sun as it revolves around Earth. Due to the moon's rotation, the dark side of the moon is facing Earth.

Fun Fact:
The sun is almost a perfect sphere.

The sun is completely hidden during a total solar eclipse, revealing the full glory of the solar corona. During these few minutes of a total solar eclipse the corona, the sun's upper atmosphere, is visible as it streams out into space above the sun's surface (or photosphere). Normally, the corona's light is not visible because it is outshone by the bright photosphere. NASA uses Earth-based instruments and satellites in space to study eclipses as they occur. Astronomers also create artificial solar eclipses with a special kind of telescope, called a coronagraph, which uses a disk to block the sun's bright surface, revealing the faint solar corona. Learn more about eclipses at NASA's Eclipse 2017 website, https://eclipse2017.nasa.gov/how-eclipses-work.

Objective:
In this activity participants will create a picture of the sun, which can then be examined with colored filters to simulate how specialized instruments enable scientists to capture images and

view different features of the sun. During an EXTENSION experience, participants will use the solar picture to model the difference between a partial and total solar eclipse.

Materials:

To create the solar images

Per class:

- Two medium-size disposable foam bowls (one for red tempera paint bubbles and one for yellow tempera paint bubbles)
- 60 mL liquid washable yellow and red tempera paint
  - Paint may be purchased at local craft or hobby stores.
- 120 mL liquid dishwashing detergent (choose a dishwashing detergent that does not contain a degreasing agent)
- 120 mL water
- Newspapers or plastic tablecloths to cover tables
- Two craft sticks for stirring paint mixtures in bowls
- Images of the sun (images may be found online at: https://sdo.gsfc.nasa.gov/data/)

Per student:

- One sheet of white cardstock

To observe the solar images

Per group of four:

- Four paper towel tubes
- Four pieces of colored cellophane to cover the end of the paper towel tube
  - Cellophane of each color: red, green, blue, and purple
  - Cellophane can be purchased at local party supply stores.
- Four rubber bands

Prior to beginning this activity, cover the end of each paper towel tube with one piece of colored cellophane. Hold the cellophane in place with a rubber band.

To model a solar eclipse

Per class:

- Four to five student-created solar images

Per student:

- One wrapped, round lollipop

Engage:

Preparation to create the solar pictures: Cover tables with newspaper or plastic tablecloths. In one bowl, mix approximately 60 mL (5 Tablespoons) of liquid dishwashing detergent, 60 mL (¼ cup) of red tempera paint, and 60 mL (¼ cup) of water. Create a second tempera paint bubble solution following the same measurements but using yellow tempera paint. If mixture is not dark enough or does not make good bubbles, add additional paint or dishwashing liquid. Stir mixture thoroughly with a craft stick.

Give each participant a clean straw. Ask them to use the straw to gently blow bubbles in the bowl. The bubbles should form a mound above the rim of the bowl.

Note: be sure participants understand to blow into the straw rather than suck on the straw. Ask the participants to carefully remove the straw from the bowl. Participants should wear safety goggles and cover their clothing to protect from potential paint splatter.

Demonstrate how participants will take the cardstock and lay it on top of the mass of bubbles. Use the red bubble mixture first and then repeat the process using the yellow bubble mixture as a second layer. Participants will push lightly on the paper tracing the rim of the bowl through the paper with fingers. The pressure of the paper will pop the bubbles and produce images similar to the hot ionized gases, or plasma, of the sun's surface.

Guide the participants to lay solar pictures flat to allow the paint to dry. This will allow the paint to set for a few moments before picking it up. Pictures are dry to touch in just a few minutes. Participants may want to put their names on their pictures because all will be similar.

Explain:

Ask participants to compare the solar pictures they have created to images of the sun downloaded from the NASA Solar Dynamics Observatory (SDO), https://sdo.gsfc.nasa.gov/data/. At no time during this experience will students actually observe the sun. ***Students should never look directly at the sun.***

As students compare their solar images to actual images of the sun, guide them to look for areas that may resemble **prominences**, **coronal mass ejections (CME)**, or **solar flares.** Definitions and descriptions of these terms can be found in the NASA eClips Virtual Vocabulary, https://nasaeclips.arc.nasa.gov/teachertoolbox/vocab. Ask participants to label these features of the sun.

> **Fun Fact:**
> Sunspots appear dark because their temperature is lower than the surrounding area.

Ask students to randomly place three or four dots on the solar image using a black marker or pen. These will represent **sunspots**.

Guide participants to look at the solar picture through one of the paper towel tubes with cellophane. Explain how they should hold the tube so the colored cellophane is away from their eye. Guide participants to compare what they see through the colored lenses to what was seen without a lens.

Ask participants to change the tubes and look at the solar images through each of the different lenses. Discuss how using the different colored lenses may change what they are able to see.

Explain how NASA scientists use different colored lenses to observe the sun. Show students the real time images of the sun posted on the NASA SDO web site: https://sdo.gsfc.nasa.gov/

Ask participants to compare their experience with the work being done by NASA's Heliophysics Division.

Extend:
Post several student-created solar images around the room. Give each participant a wrapped lollipop that will model Earth's moon.

Ask participants to hold the lollipop eye level and move forward and backward until the object appears to cover the solar image. Discuss how far away from the wall the participant is standing. If possible, mark a line one meter (3.2 feet) parallel to the wall, at this distance.

Fun Fact:
The distance between Earth and the sun changes because Earth travels around the sun in an elliptical orbit.

Ask participants to stand at different points on the line and describe how much of the sun is eclipsed by the lollipop at each point. The participants will be the same distance from the sun, but different angles to the sun image. At the original distance from the sun image, participants model a total eclipse. At the other points, participants model varying partial eclipses.

Discuss these points:

- What natural body does the lollipop model?
- The lollipop is much smaller than the object on the wall. Why does the lollipop appear to cover the object?
- What happens as you stand at different points on the line?
- Why do you think this happens?
- What do you know about solar eclipses? Why do you think eclipses occur?
- How often do solar eclipses occur?
- What is the difference between a partial eclipse and a total eclipse?

Eclipses follow a path, described as the path of totality. Different geographic locations fall within this path of totality. Refer to this map to see the path of totality for the 2017 solar eclipse, https://eclipse2017.nasa.gov/sites/default/files/eclipse_full_map.pdf

To learn more about the sun, watch the NASA eClips™ video segment, *Our World: The Sun, A Real Star*, which can be viewed or downloaded at: https://nasaeclips.arc.nasa.gov/

To learn more about NASA's STEREO mission and the twin satellites used to collect data about the sun, watch the NASA eClips™ video segment, *Real World: Satellites and Solar Eruptions*, which can be viewed or downloaded at: https://nasaeclips.arc.nasa.gov/

To learn more about solar eclipses, watch the NASA eClips™ video segment, *Launchpad: Solar Eclipses*, which can be viewed or downloaded at: https://nasaeclips.arc.nasa.gov/