NATIONAL GEOGRAPHIC

RESOURCE LIBRARY
ACTIVITY : 1 HR 30 MINS

Build a Sunspot Viewer

Students construct a pinhole viewer to safely observe the sun and sunspots.

GRADES

3 - 8

SUBJECTS

Earth Science, Astronomy, Experiential Learning, Mathematics

CONTENTS

1 Video, 3 Images, 1 PDF

OVERVIEW

Students construct a pinhole viewer to safely observe the sun and sunspots.

For the complete activity with media resources, visit:
http://www.nationalgeographic.org/activity/build-a-sunspot-viewer/

Program

WILDEST WEATHER IN THE SOLAR SYSTEM

DIRECTIONS

1. Watch the NASA video "What are sunspots?"
Show students the NASA video "What are sunspots?" Provide support for vocabulary terms *sunspots*, *magnetic field*, *photosphere*, *convection*, and *atmosphere*, as needed. Then check students' understanding. Ask students to restate the comparison of sunspots to light bulbs in their own words.

2. Introduce the activity and safety concerns.
Explain to students that looking directly at the sun is very dangerous and can cause permanent damage to human eyes. Make sure that students understand that no one—not even scientists—ever look directly at the sun. Instead, scientists use methods that allow them to observe the sun indirectly. In this activity, students will build a pinhole viewer that will allow them to observe the sun indirectly and safely.

3. Have students build a pinhole viewer to view sunspots.
Divide students into small groups of 3 or 4. Before students begin, project the step-by-step illustration for them to refer to as they build their viewers.

- Take the cardboard box and cut a 2 centimeter x 2 centimeter hole at one end.
- Tape a piece of aluminum foil over the hole, making sure it is taut.
- Carefully use the pushpin or sewing needle to poke a hole into the foil.
- At the opposite side of the box, cut a small window about 1 centimeter from the end. The window should be no larger than 10 centimeters x 3 centimeters. Make sure that the window is no wider than the side of the box.
- Tape a piece of white paper to the inside of the box. This will be your viewing screen.
- Aim the pinhole side of the projector at the sun. Keep positioning the projector until you have the image of the sun on your screen. It will appear to be a white disk.

4. Have students make a math connection.
Tell students that they can gather data from their sunspot viewer activity to calculate, or figure out, the diameter of the sun. First model, and then have them do the following steps in order:

- Draw a circle around the image of the projected sun on the paper. Find the center of the circle by folding the circle twice making sure the outer edges of the circle line up. For a more precise method, students can use the chord bisector method, described below. Place a dot in the exact center of the circle.
- Draw any two chords, or line segments that cross in two places on the circumference of the circle.
- Draw a line segment perpendicular (at a 90° angle) to the chord toward the center of the circle.
- Repeat with the second chord.

- Find the center of the circle at the point where the two perpendicular lines drawn intersect or cross.
- Then, use a ruler to measure the distance from the center of the circle to one side of the circle in centimeters. This is the radius of the circle. Multiply the radius by 2 to calculate the diameter.
- Use a ruler to measure the distance from the pinhole to the paper. The pinhole is on the opposite side of the box from the paper. Calculate the distance by measuring the length of the box. Measure using centimeters.
- Finally, use this formula: Diameter of the image of the sun ÷ distance from the pinhole to the paper × distance from Earth to sun, approximately 149,600,000 kilometers (92,957,130 miles) = diameter of the sun

Note that students should arrive at a result for the diameter of the sun that is approximately 1.4 million kilometers (870,000 miles). Explain the relative size of the Earth and the sun. Tell students that the sun's diameter is about 100 times that of the Earth.

5. Have students use their pinhole camera to track sunspots over a period of time.
Explain to students that sunspots can serve as markers to help us see the sun's rotation. Distribute one copy of the worksheet Sunspot Mapping Grid to each group. Ask groups to sketch and label each sunspot for 10 days.

6. Have a whole-class discussion about what students observed over time.
After students have tracked sunspots for ten days, have a whole-class discussion about what they observed. Ask:

- *Have the sunspots moved? Describe their movement.*
- *Have the shapes and sizes of the sunspots changed? How?*
- *Are there fewer sunspots or more sunspots? Why do you think that is?*
- *What did you learn about the sun's rotation by tracking sunspots over time?*

Students should understand that the sun rotates, which causes sunspots to vary over time in a regular and somewhat predictable way.

TipSafety

Periodically remind students to never look directly at the sun. Make sure students understand they can cause irreversible damage to their eyes without using the proper equipment and techniques to view the sun.

Modification

Simplify Step 4 for students in younger grades. Instead of using the chord bisector method, have them trace, cut, and fold the circle in half. Then measure that line to establish diameter.

Informal Assessment

Have each student write a brief paragraph defining what sunspots are and explaining what can be learned about the sun's rotation by tracking sunspots. Encourage students to use vocabulary terms *sunspots*, *magnetic field,* and *photosphere* in their paragraphs.

Extending the Learning

Have students use the National Geographic sun interactive The Center of it All to learn more about surface features of the sun, such as sunspots, solar flares, and solar prominences.

OBJECTIVES

Subjects & Disciplines

Earth Science

- Astronomy
- Experiential Learning
- Mathematics

Learning Objectives

Students will:

- explain the importance of safety when observing the sun
- gather data and calculate the diameter of the sun
- track sunspots and make observations about them

Teaching Approach

- Learning-for-use

Teaching Methods

- Cooperative learning
- Discussions
- Hands-on learning
- Inquiry

Skills Summary

This activity targets the following skills:

- 21st Century Student Outcomes
  - Learning and Innovation Skills
    - Communication and Collaboration
- Critical Thinking Skills
  - Analyzing
  - Creating
  - Understanding

National Standards, Principles, and Practices

NCTM PRINCIPLES AND STANDARDS FOR SCHOOL MATHEMATICS

• **Algebra (6-8) Standard 4:**
Analyze change in various contexts
• **Data Analysis & Probability (6-8) Standard 2:**
Select and use appropriate statistical methods to analyze data
• **Geometry (3-5) Standard 2:**
Specify locations and describe spatial relationships using coordinate geometry and other representational systems

NATIONAL SCIENCE EDUCATION STANDARDS

• **(5-8) Standard B-3:**
Transfer of energy

• **(5-8) Standard D-3:**
Earth in the solar system
• **(K-4) Standard D-2:**
Objects in the sky

ISTE STANDARDS FOR STUDENTS (ISTE STANDARDS*S)

• **Standard 2:**
Communication and Collaboration

Preparation

What You'll Need

MATERIALS YOU PROVIDE

- Aluminum foil
- Pencils
- Rulers
- Sewing needles or push pins
- Shoeboxes, or 2-foot rectangular cardboard boxes
- Telescope or binoculars
- Transparent tape
- White paper
- White poster board

REQUIRED TECHNOLOGY

- Internet Access: Required
- Tech Setup: 1 computer per classroom, Projector, Speakers
- Plug-Ins: Flash

PHYSICAL SPACE

- Classroom
- Outdoor natural environment

SETUP

Open space

GROUPING

- Small-group instruction

OTHER NOTES

Ideally, this activity will take place over ten days.

BACKGROUND & VOCABULARY

Background Information

The sun is responsible for all life on Earth; it gives us light and heat. The sun is not a solid body; it is a giant ball of gas, made mostly of hydrogen and helium. The surface of the sun is called the photosphere. Sunspots are cooler regions on the sun, caused because of a strong magnetic field. Sunspots appear dark only because they are not as hot or bright as the area surrounding them. The average surface temperature of the sun is 6,273 Kelvin (6,000 degrees Celsius). Sunspots are about 4,773 Kelvin (4,500 degrees Celsius).

Prior Knowledge

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Recommended Prior Activities

- None

Vocabulary

Term	Part of Speech	Definition
atmosphere	*noun*	layers of gases surrounding a planet or other celestial body.
chord	*noun*	straight line segment joining and included between two points on a circle.
convection	*noun*	transfer of heat by the movement of the heated parts of a liquid or gas.
diameter	*noun*	width of a circle.

Term	Part of Speech	Definition
Kelvin scale	*noun*	scale for measuring temperature where zero Kelvin is absolute zero, the absence of all energy.
magnetic field	*noun*	area around and affected by a magnet or charged particle.
photosphere	*noun*	lowest visible layer of a star and the boundary from which the star's diameter is measured.
sunspot	*noun*	dark, cooler area on the surface of the sun that can move, change, and disappear over time.

For Further Exploration

Websites

- High Altitude Observatory (HAO): Questions and Answers About the Sun
- NASA: Solar and Heliospheric Observatory (SOHO)
- National Solar Observatory
- National Geographic Science: Space
- NASA: Living with a Star—The Sun-Earth Connection
- Solar and Heliospheric Observatory (SOHO): Real Time GIF Movies
- Solar and Heliospheric Observatory (SOHO): Our Star the Sun
- Stanford Solar Center
- National Geographic Science: The Sun—Living With a Stormy Star
- Nat Geo Movies: Wildest Weather in the Solar System

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