Module 1: What are the parts of the Sun?

Activity C: Solar Research in Action! – Create a Pinhole Camera

Overview

There are several ways you can safely observe the Sun, and hopefully sunspots, yourself. The easiest way is to use a pinhole camera. A pinhole camera works by projecting the Sun's light through a tiny pinhole onto a white sheet of paper, which allows you to easily and safely observe the Sun. Galileo safely observed the Sun by projecting its image from a telescope onto light colored paper, which is how he discovered sunspots. Galileo made many drawings of the Sun that traced the path of sunspots across the surface of the Sun. His original solar sketches still survive today!

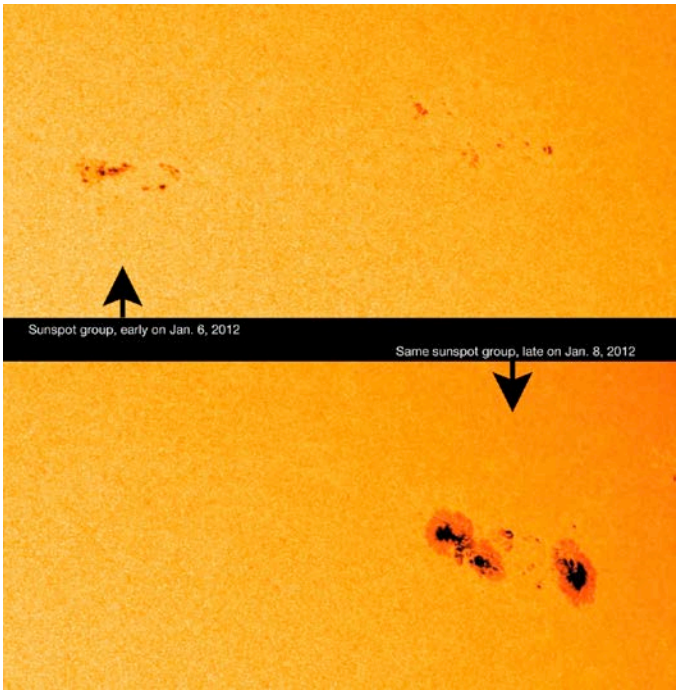


Image: NASA

Team Goal

As a group, your goal is to construct a pinhole camera to project a visible light image of the Sun in order to safely observe the Sun and calculate the Sun's diameter.

Teacher Overview

All modules in the SDO Project Suite are student-led activities, which means the role of the teacher is to support student learning rather than directly lead it. This student-as-scientist method of learning incorporates active team collaboration of researching scientific concepts along with individual review and reinforcement of the concepts learned. The objective of Solar Module 1 is to provide students with a fundamental understanding of the Sun's structure and function. The focus of Module 1C is to enable students to indirectly (safely) view the Sun as a means to conclude that the Sun is the source of light and energy on Earth. This foundational knowledge will be further explored and developed in Solar Modules 2 & 3 and presented in the performance-based Module 4 SDO Exploration Museum 3-D Solar Exhibit.

Objectives

Students will be able to:

- Understand that radiant energy from the Sun can be viewed as Visible Light on Earth.
- Project an image of the Sun to calculate an estimation of the Sun's diameter.

Essential Vocabulary

- Chromosphere
- Diameter
- Model
- Photosphere
- Ratio
- Scale

Materials

- "Create a Pinhole Camera" lab sheet
- Sturdy box with lid (shoe box
- 2 index cards
- Pin
- Tape
- Aluminum foil
- Ruler
- Meter stick
- Scissors or utility knife
- Calculator
- Pencil
- Sunny day!

Engage & Explore!

1. BUILD Knowledge:

About SDO and safe Sun viewing

Watch these videos to learn about how NASA's Solar Dynamic Observatory (SDO) is observing the Sun and how your team can safely observe the Sun, too!

Intro to SDO Video
SDO Science Overview Video
How to Safely View the Sun Video

WARNING: TO AVOID SERIOUS, PERMANENT EYE DAMAGE, NEVER LOOK DIRECTLY AT THE SUN WITH YOUR EYES, TELESCOPE OR BINOCULARS UNLESS YOU USE THE PROPER SOLAR FILTERS (sunglasses are NOT proper solar filters)!!!

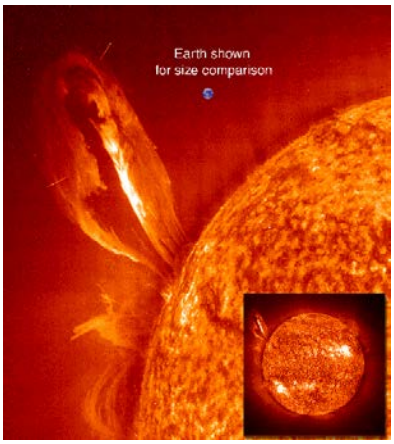


Image: NASA

Module Lesson
Time: 1 block period/2 class periods

Materials: per team

- "Create a Pinhole Camera" lab sheet
- Sturdy box with lid (shoe box
- 2 index cards
- Pin
- Tape
- Aluminum foil
- Ruler
- Meter stick
- Scissors or utility knife
- Calculator
- Pencil
- Sunny day!

Teacher Prep:

- Prepare a sample pinhole camera as a student demonstration
- Print copies of "Create a Pinhole Camera" lab sheets
- Prepare remaining materials for each group

Student Engage/Explore Activities

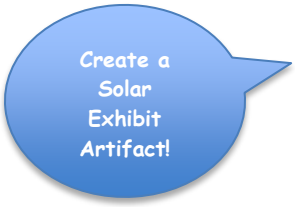
1. BUILD Knowledge:

About SDO and safe Sun viewing

First, teams watch two videos to be introduced to NASA's Solar Dynamic Observatory (SDO) and to learn how to safely observe the Sun without permanently damaging one's eyes.

Intro to SDO Video
SDO Science Overview Video
How to Safely View the Sun Video

WARNING: TO AVOID SERIOUS, PERMANENT EYE DAMAGE, NEVER LOOK DIRECTLY AT THE SUN WITH YOUR EYES, TELESCOPE OR BINOCULARS UNLESS YOU USE THE PROPER SOLAR FILTERS (sunglasses are NOT proper solar filters)!!!



2. CREATE Resources & CONNECT to the Real World:

Create a pinhole camera

Together as a team, carefully read through the instructions on how to make a pinhole camera and review the images and demonstration camera to assist your team. Then, collect your materials and build your own pinhole camera! Use your pinhole camera to project an image of the Sun to estimate the diameter of the Sun. Finally, create a scale Sun-Earth model based on the Sun's diameter and distance from Earth. Your team's pinhole camera (plus images taken with it) and scale Sun-Earth model will be used as an artifacts for your team's Module 4 SDO Exploration Museum 3-D Solar Exhibit.

Create a Pinhole Camera Lab Sheet (see attached file)

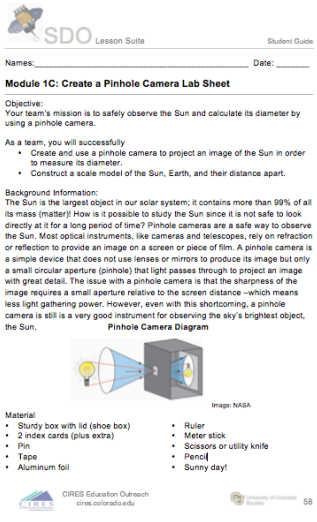
Student Engage/Explore Activities

2. CREATE Resources & CONNECT to the Real World:

Create a pinhole camera

Student teams work together and read the pinhole camera instructions aloud. Remind teams to review the diagrams and refer to the demonstration pinhole camera to help them build it. Next, teams collect their materials and build their own pinhole camera. Using their pinhole camera, teams then complete the activity to estimate the diameter of the Sun. Once the Sun's diameter is estimated, teams create a scale Sun-Earth model.

Create a Pinhole Camera Lab Sheet (see attached file)



SDO Lesson Suite Student Guide

Names:_____ Date: _____

Module 1C: Create a Pinhole Camera Lab Sheet

Objective:
Your team's mission is to safely observe the Sun and calculate its diameter by using a pinhole camera.

As a team, you will successfully
- Create and use a pinhole camera to project an image of the Sun in order to measure its diameter.
- Construct a scale model of the Sun, Earth, and their distance apart.

Background Information:
The Sun is the largest object in our solar system; it contains more than 99% of all its mass (matter)! How is it possible to study the Sun since it is not safe to look directly at it for a long period of time? Pinhole cameras are a safe way to observe the Sun. Most optical instruments, like cameras and telescopes, rely on refraction or reflection to provide an image on a screen or piece of film. A pinhole camera is a simple device that does not use lenses or mirrors to produce its image but only a small circular aperture (pinhole) that light passes through to project an image with great detail. The issue with a pinhole camera is that the sharpness of the image requires a small aperture relative to the screen distance –which means less light gathering power. However, even with this shortcoming, a pinhole camera is still is a very good instrument for observing the sky's brightest object, the Sun.

Pinhole Camera Diagram

Image: NASA

Material
- Sturdy box with lid (shoe box)
- 2 index cards (plus extra)
- Pin
- Tape
- Aluminum foil
- Ruler
- Meter stick
- Scissors or utility knife
- Pencil
- Sunny day!

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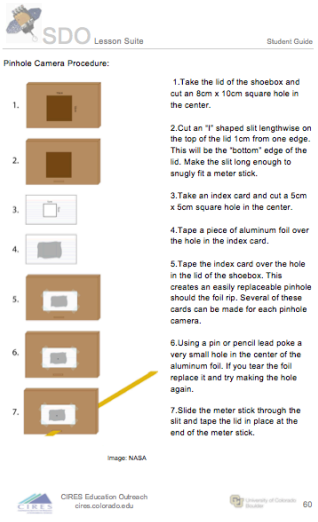

SDO Lesson Suite Student Guide

Pinhole Camera Procedure:

1. Take the lid of the shoebox and cut an 8cm x 10cm square hole in the center.
2. Cut an "I" shaped slit lengthwise on the top of the lid 1cm from one edge. This will be the "bottom" edge of the lid. Make the slit long enough to snugly fit a meter stick.
3. Take an index card and cut a 5cm x 5cm square hole in the center.
4. Tape a piece of aluminum foil over the hole in the index card.
5. Tape the index card over the hole in the lid of the shoebox. This creates an easily replaceable pinhole should the foil rip. Several of these cards can be made for each pinhole camera.
6. Using a pin or pencil lead poke a very small hole in the center of the aluminum foil. If you tear the foil replace it and try making the hole again.
7. Slide the meter stick through the slit and tape the lid in place at the end of the meter stick.

Image: NASA

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Awesome, your team safely observed the Sun.
Galileo would be proud!

Differentiation/Extension

Sunspot Drawings:

Image: Galileo Galilei

Until recently, astronomers have had to rely on drawings or sketches to document what they've seen when observing the Universe. The invention of telescope mounted cameras and other technology has advanced how astronomers observe and record what they see in Space. However, historic drawings are still very important. Drawings of sunspots have been done for hundreds of years and Galileo's original sunspot drawings still survive today. The solar telescope at Mt. Wilson, above Pasadena, California, has been recording sunspot drawings since 1917 and continues to do so today. You can check the day's current sunspot drawings and compare them with your own sketches:
Daily Sunspot Drawings at Mt. Wilson
Galileo's Sunspot Drawings

Internet Resources
NASA's The Space Place: Make a Pinhole Camera
JPL How to Make a Pinhole Camera
Stanford Solar Center Observing the Sun for Yourself
Observing Solar Eclipses
Little Sunspotter Telescope
Discovering the Sun - Galileo