Sun As A Star

Science Learning Activities for Afterschool

Participants ages 5-12

EDUCATOR RESOURCE GUIDE

Credits & Acknowledgements

Original Activity Sources

Discovering the Universe by the American Museum of Natural History
http://www.amnh.org/education/resources/moveable_astro/index.php

Northern Lights, Solar Sprites produced by IMAGE Education and Public Outreach Team, NASA Goddard Space Flight Center.
http://teachspacescience.org/graphics/pdf/10000151.pdf

Telling Time with the Sun, NASA for Kids web site
http://www.nasa.gov/audience/forkids/activities/A_Make_a_Sundial.html

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Preface

The Sun as a Star: Science Learning Activities for Afterschool was produced by the American Museum of Natural History (AMNH) as part of an 18 month study and demonstration project funded by NASA. The demonstration project collected a wide range of existing NASA and AMNH educational resources developed for formal school settings. It drew on AMNH's experience to adapt the materials for community-based afterschool program staff working with participants aged 5-12. Materials were tested in afterschool programs operated by the local affiliate of a national youth-serving organization, an independent community-based organization, and a public school. Afterschool participants and staff were engaged as co-researchers with the AMNH staff. Observations were conducted by the AMNH staff, and interviews were conducted with the afterschool staff and participants. Written data was collected from instructors in the form of weekly summary sheets and from participants in the form of science journals.

The key findings from the demonstration project were:

- Young people are highly interested in what the universe is like and how it has developed over time.
- The most powerful part of the learning experience in the demonstration project was the opportunity for participants to express their ideas and opinions, and learn to build explanations from evidence.
- Afterschool staff with youth development training have a set of skills that are applicable to leading inquiry and discussion-based science learning experiences.

The Sun as a Star: Science Learning Activities for Afterschool is one of three prototype curriculum packets produced to capture the work done in the project and make it available to other interested afterschool programs. Each packet contains a collection of activities adapted from existing resources, for use by afterschool instructors with participants aged 5 – 12. These are the activities which were the most successful in the demonstration sites and which build upon the project's findings. The packet is a "prototype" in the sense that it serves as one example of how existing NASA educational resources can be adapted for use in the afterschool setting. Each activity instruction sheet contains a reference to the original activity and an internet link for obtaining the original.

The complete report on the demonstration project and the scan of the field that accompanied it, *NASA and Afterschool Programs: Connecting to the Future* can be downloaded from the NASA Informal Education web portal at the address below.

http://education.nasa.gov/divisions/informal/overview/R_NASA_and_Afterschool_Programs.html

Introduction

The *Sun as a Star* consists of eight Activities, each of which may be completed in about one hour. The Activities are targeted for the elementary school level.

Navigating Through the Activities

The format is geared towards helping the instructor navigate efficiently through each hour-long Activity. The headings contain brief but pertinent information.

- **The Overview** gives you a quick summary of the Activity and the estimated time for each.
- **Connections** help you make sense of the flow of the unit by relating the topic of the Activity to those that come before or after it. You may use this section to introduce an Activity and to help participants connect to what they have already done or will be doing in subsequent activities.
- **The Big Ideas** present the background information and the concepts that are addressed in the Activity.
- **The Materials** section lists everything you will need to use that day. In many cases, the materials are commonly available supplies. Most images listed are provided either as handouts or online. There are some items you will need to gather yourself, and these are clearly outlined. Be sure to preview the Materials section in advance. Please see the complete Materials list for the entire unit on page 6.
- **The Preparation** section lets you know what you need to get ready ahead of time.
- **The Activity** is presented in a step-by-step style. The main objective in each step comes first, in bold print as a visual cue. A brief paragraph explains the step in more detail and also provides questions and prompts to use with participants.

SPECIAL SAFETY WARNING: The Sun
In this unit, the Sun will be the central topic of study. It should continually be emphasized to participants, over and over again, that they should NEVER look directly at the Sun. It only takes a few seconds of direct sunlight to do permanent damage to the eye. The activity instructions will also include prompts to remind participants of this at key points in the activity, but it should also be a message continually repeated as the participants study the Sun,

Overview

The unit opens with a brainstorming session in which participants share their prior knowledge about the Sun and make the first entries in their Science Journals.

In **Activity 2**, participants are introduced to the idea that light is our means of studying the Sun. They observe how a prism separates white light into its component colors, and then construct their own spectroscopes to explore the visible colors in light.

Activity 3 expands on participants' understanding of light by focusing on invisible UV light. They use UV detecting beads to experiment with artificial light and sunlight. Then they select among a variety of sunblockers to find out which ones offer the best protection from UV light.

In **Activity 4**, two experiments help participants to find out how light travels. In the first, they use opaque and transparent objects to observe that light can be blocked and describe the resulting shadows. In the second experiment, participants use mirrors to reflect light and find out if they can make light bend or turn corners.

In **Activity 5**, participants set up an outdoor investigation to find out how the size and position of shadows relate to the position of the Sun in the sky. They construct sundials and use them to track the Sun's position over time.

Activity 6 asks if the Sun moves. Participants explore the question by constructing models. One investigation involves using the sundials and a flashlight to represent the Sun. The other challenges participants to create a model using balls, pins, and a light source to demonstrate how light from the Sun moves across the Earth.

In **Activity 7**, participants view images of the Sun taken by the SOHO satellite. The activity reinforces the idea that light is our tool for studying the Sun, and introduces the idea that scientists use the different colors of light given off by the Sun to learn more about it.

Activity 8 extends participants' thinking about the Sun as a star, and as one of many stars in the sky. They view images of stars and try to estimate their numbers. Then they classify stars by color and brightness. As a closing activity, participants record their ideas on whether or not all stars are like the Sun, and discuss the importance of studying our nearest star.

Materials

For Activity 1

- White board, chalk board, or pad of chart paper and chalk or markers
- 1 science journal for each participant (See preparation on Page 7)

For Activity 2

- 1 prism
- A light source to use with the prism (such as a flashlight, lamp, or projector)
- Materials for spectroscopes. The complete lists of materials for the two types of spectroscopes are on the handouts labeled Spectroscope Pattern #1 and #2.

For Activity 3

For each participant:
- 4 or 5 UV detecting beads (available at www.teachersource.com/catalog/indext.html)
- 1 pipe cleaner

For the group:
- A variety of potential UV blockers (sunscreen, cloth, paper, water)

For Activity 4

For each group:
- 1 flashlight
- Several small opaque and transparent objects
- 2 or 3 small mirrors

For Activity 5

For the outdoor shadow activity:
- A safe outdoor area to explore on a sunny day
- 1 large sheet of paper
- 1 ruler or yardstick
- An object that casts a narrow shadow

For constructing a sundial:
For each participant:
- 1 paper plate
- Scissors
- Glue, gluestick, or tape
- "A Simple Design for a Sundial" handout
- "Telling Time with a Sundial" handout

For Activity 6

- Sundials that participants constructed in the previous session
- 1 flashlight

For each group of 3 to 4 participants:
- 1 styrofoam or clay ball
- 1 push pin, straight pin, or toothpick
- 1 flashlight or other light source such as a lamp or projector
- 1 stick or pencil to use as a handle for the ball

For Activity 7

- Either class access to the internet or print outs of recent color images of the Sun from the SOHO website, http://sohowww.nascom.nasa.gov/

For Activity 8

For each group of 3 to 4 participants:
- "Star Image" handout, one copy in color and one in black & white

1. What Do We Know About The Sun?

Overview

In a brainstorming session, participants share their prior knowledge about the Sun and discuss why the Sun is important to the Earth. They make their first entries in their science journals.

TIME:
• 45 minutes

Big Ideas

• The Sun is the major source of energy that controls Earth's environment and supports life.

Connections

The opening activity sets the stage for thinking about the Sun and its effects on the Earth.

Materials

• White board, chalk board, or large piece of chart paper and chalk or markers

• 1 science journal for each participant

Preparation

1. Label the chart or board with the topic question: What do we know about the Sun?

2. Each participant will need a science journal to record thoughts, observations, and findings over the coming weeks. There are a number of ways to create journals if you are not providing ready-made ones. For example:
• Have participants make folders from construction paper. They can then insert loose leaf paper (both lined and drawing paper) into the folders.
• Fold sheets of large paper in half. Either staple the sheets together or punch holes and tie the sheets together with string or yarn.

1. What Do We Know About The Sun?

Activity

1. Open a brainstorming session on the question and record participants' ideas.

Explain that over the next few weeks, participants will be learning more about the Sun and what it does for the Earth and other objects in space. But first, before they start learning new things, they will share what they already know about the Sun.

If necessary, briefly review the ground rules for a brainstorming session:
- Everyone gets a chance to contribute, and all ideas are recorded on the chart or board.
- There are no right or wrong ideas in a brainstorming session.
- Listen to everyone's ideas. You may repeat an idea and expand on it, or you may disagree and give your reasons for disagreeing.

Give participants a few minutes to think about the question, and then invite them to share their prior knowledge. Record their list of ideas on the chart or board you have prepared for this purpose.

If necessary, use some of these prompts:
- What does the Sun look like?
- What is it?
- What else do you know about the Sun?
- What does the Sun do for the Earth?

2. Introduce the Science Journals.

Explain that participants will be keeping journals throughout their investigations. They may record their discoveries, data, thoughts, and ideas by writing and by drawing, the way that working scientists do.

Then have participants make their first entries in the journals. Give them these instructions:
- Label the journal page with today's date and the question "What do I know about the Sun?"
- Record everything you know about the Sun both in writing and drawings.

3. Share journals.

If time permits, invite participants to share their journal entries. Often they learn a great deal from each other's strategies for recording.

2. What Colors Are In White Light?

Overview

Participants observe how a prism separates light into its component colors. They construct their own spectroscopes and then use them to observe both artificial and natural light from the Sun.

TIME:
- 60 minutes

Big Ideas

- Light from the Sun contains all the colors of the rainbow.
- Light is one of the ways we can learn more about the Sun.

Connections

Light is our means of studying the Sun. In this activity and in several more to follow, participants experiment with light to learn more about the Sun.

Materials

- 1 prism
- A light source to use with the prism (such as a flashlight, lamp, or projector)
- Materials for spectroscopes. The complete lists of materials for the two types of spectroscopes are on the handouts labeled "Spectroscope Pattern #1 and #2".

Preparation

1. Look at the materials and preparation required for each of the two different spectroscopes and decide which one you will use. Please see the handouts called "Spectroscope Directions for Instructors" and "Spectroscope Pattern #1 and #2".
2. Follow the instructions on the handout to prepare the materials for the spectroscope you have selected.

2. What Colors Are In White Light?

Activity

1. Open a discussion on light.

Ask:
• What color is light?
• Does light come in more than one color?

Some participants may be familiar with rainbows or prisms and their connection to light. Others might think about neon lights or other colored lights they have seen. For still others, the idea of connecting light to color may be completely new.

2. Observe light shining through a prism.

Shine a light source through a prism. Ask:
• What do you observe?
• What colors do you see? In what order are the colors?

Explain that white light is really made up of all the colors of the rainbow (red, orange, yellow, green, blue, indigo, and violet). A prism separates the light into its individual colors.

3. Observe light shining on a CD.

Hold up an intact CD and move it back and forth in the beam of light so that participants can observe the effect. Ask:
• What do you observe?
• How are the colors like the ones you observed when we shined a light through the prism?

Explain that the group is going to make a device that works like a prism that will allow them to see the colors that make up light. The device is called a spectroscope.

4. Build a spectroscope.

Distribute the materials and the directions for building a spectroscope. Have participants follow the directions to complete their tool. If necessary, lead them through the construction step by step.

2. What Colors Are In White Light? - Activity

5. Use the spectroscope to observe the colors in white light.

Have participants look through the eyehole and point the slit end towards a light source in the room. They will need to move their heads and the spectroscope around until they find the right angle and can see the bands of different colored light on the CD wedge.

Encourage participants to look at different light sources in the room.

6. Observe the colors in sunlight. Emphasize safety: never look directly at the Sun.

Explain that the group will next observe the colors in sunlight. Point out that it is VERY important not to point the spectroscopes directly at the Sun. That could damage their eyes. Instead, they should point their spectroscopes towards a bright area of the sky.

Have participants go to a window and look at the colors in sunlight.

6. Wrap up: Discussion on the colors in light.

To focus the discussion ask:
- What colors did you see in the spectroscope when you were looking at indoor artificial light?
- Did you see the same colors in sunlight?

Encourage participants to take their spectroscopes home with them and look at different light sources in their homes and neighborhoods. They will be interested to see the spectrum produced by neon lights, television screens, computers, and fluorescent tubes.

This activity was adapted from "Building a Spectroscope" from *Discovering the Universe* produced by the American Museum of Natural History
http://www.amnh.org/education/resources/rfl/pdf/du_x01_light.pdf

3. How Can We Find Out About Invisible Light?

Overview

Participants make UV light detector bracelets and use them to experiment with artificial light and sunlight. Then they experiment with a variety of materials to find out which ones give the best protection from UV light.

TIME:
• 45 minutes

Big Ideas

• Light from the Sun contains all the colors of the rainbow as well as colors that we cannot see, such as ultraviolet light.

• UV light affects our daily lives.

• Scientists have instruments that can detect light our eyes do not see. The instruments help us to get a more complete picture of the universe.

Connections

In the previous activity, participants learned that light can be broken into its visible colored components. Now they will explore the invisible end of the light spectrum, ultraviolet light (UV).

Materials

For each participant:
• 4 or 5 UV detecting beads (available at www.teachersource.com/catalog/indext.html)
• 1 pipe cleaner

For the group:
variety of potential UV blockers. Try anything you think might be interesting, such as:
• sunscreen
• paper towels
• plastic wrap
• black construction paper
• cloth (baseball cap, tee shirt, etc.)
• cups of water

Preparation

No advanced preparation beyond the collection of materials is necessary for this activity.

3. How Can We Find Out About Invisible Light?

Activity

1. Have participants share what they know about UV light.

Ask:
• Where did we observe violet light when we used the prism and spectroscopes? Did you see anything beyond violet?
Explain that there is one type of light that we cannot see called UV or ultraviolet light. It is called ultraviolet because it is past violet on the rainbow.

• What does UV light do?
Participants may know that UV light causes our skin to burn

• If UV light is invisible, how can we find out more about it?
Explain that scientists have built instruments that allow them to detect some kinds of light that our eyes cannot see. We will now build and use some personal UV light detector bracelets.

2. Make UV light detector bracelets.

Distribute pipe cleaners and UV detecting beads to the group. Have them string 4 or 5 beads on the pipe cleaner, loop the pipe cleaner around their wrists, and twist the ends together to fasten the bracelets.

3. Use the UV light detector bracelets to experiment with artificial indoor light.

Explain that the UV detecting beads will change color only when they are exposed to UV light.

Invite participants to find out if artificial indoor lighting contains UV light. Encourage them to experiment by exposing their UV beads to a number of light sources such as a flashlight, overhead projector, and fluorescent light. The UV detector beads should stay the same color.

4. Use the UV light detector bracelets to find out if sunlight contains UV light.

Ask the group make a prediction:
• What do you thing would happen if we exposed our UV light detectors to sunlight?

Then either take the UV detectors outside or hold them in a sunny window. Now they should change color.

Remove the bracelets from the sunlight in preparation for the next experiment.

3. How Can We Find Out About Invisible Light? - Activity

5. Experiment with sunblockers to find out which ones can protect us from the Sun's harmful UV light.

Show participants the collection of sunblockers you have provided. Have small groups select one sunblocker and use it to try to keep UV light from reaching their beads.

Remind participants not to put the beads in sunlight until they have covered them with the protector they selected.

Check the bracelets after five minutes.

6. Wrap up: Discuss the results of the experiments.

Ask:
- What did you find out about artificial light and sunlight?
- What kinds of sunblockers protect best from UV light? What worked and what didn't work?

This activity adapted from "Detecting UV Light" in *Discovering the Universe*, developed by the American Museum of Natural History
http://www.amnh.org/education/resources/rfl/pdf/du_x01_light.pdf

4. How Does Light Travel?

Overview

Participants perform two sets of experiments with light. The first explores blocking light to create shadows. The second asks participants to figure out how light travels by using mirrors.

TIME:
- 60 minutes

Big Ideas

- Light travels in a straight line.
- Light can be blocked by opaque objects. This creates shadows.
- Light can be reflected.

Connections

Participants explore how light travels, setting the stage for connecting the Sun to other stars in the sky.

Materials

For each group:
- 1 flashlight
- several small opaque and transparent objects
- 2 or 3 small mirrors
- 1 science journal for each participant

Preparation

Darken the room for the activities.

4. How Does Light Travel?

Activity

1. Set up the first experiment: What are shadows? What makes a shadow?

Have participants record the above questions in their science journals, then distribute a flashlight and a collection of objects (both opaque and transparent) to each group. Have participants use the flashlight and objects to try to answer the questions.

As they experiment, circulate among the groups and ask them to explain what they are doing.

2. Record findings.

When it seems that experimentation is winding down (after about 15-20 minutes), ask participants to put down the equipment and record in their journals what they found out about shadows. Encourage them to use both writing and drawings.

3. Discuss findings.

Ask the group to share their findings. Use some of these prompts:
- What objects made shadows?
- Were there differences in how dark the shadows of different objects were? Why do you think that was?
- What happens to the light that gets blocked by the object?

4. Set up the second experiment: How does light travel? Can you make it bend? Can you make it go around corners?

Ask participants to record the new questions in their science journals. Distribute the mirrors, and set the ground rules: the mirrors are tools that are to be used safely and properly in this experiment. They should not be used to shine a bright light into a person's eyes.

As participants experiment, circulate among them as before, and ask them to explain what they are doing.

4. How Does Light Travel? - Activity

5. Record findings of the second experiment.

After about 20 minutes, ask participants to put down the equipment and record their findings in their journals, both in writing and drawings.

6. Discuss findings.

Ask participants to share what they discovered about how light travels. Ask:
- How does light travel? In what kind of path?
- Could you bend the light?
- Could you make it travel around corners?

5. What Can We Learn About The Sun From Shadows?

Overview

Participants explore the relationship between the size and position of shadows and the position of the sun. They make sundials to use outdoors.

TIME:
• 60 minutes

Big Ideas

• The Sun appears to move across the sky, but things are not always as they appear.

Connections

This activity provides a concrete connection to the Sun through direct observation of sunlight and shadows. It prepares participants for an upcoming discussion and modeling of the Sun's apparent motion across the sky.

Materials

For the outdoor shadow activity:
• A safe outdoor area to explore on a sunny day
• 1 large sheet of paper
• 1 ruler or yardstick
• An object that casts a narrow shadow (see Preparation)
• 1 Science Journal per participant

For the constructing a sundial activity:
For each participant:
• 1 paper plate
• scissors
• glue, gluestick, or tape
• "Sundial Handout" (Choose the version for the latitude which is closest to your latitude. You can find your latitude at http://terraserver.microsoft.com).

Preparation

1. Select a suitable, safe outdoor site. Locate an object at the site that casts a narrow shadow. The object needs to be short enough for participants to measure its height. If nothing is available in the outdoor area, set a broom or yardstick in a coffee can full of gravel or sand, or pound a sturdy stake into the ground, or set a clean plunger on the pavement as in the illustration for Step 2.

2. Make copies of the sundial gnomon on heavy paper. The gnomon is the part of the sundial that will stand up on the paper plate and cast a shadow.

5. What Can We Learn About The Sun From Shadows?

Activity

1. Prepare for the field trip to explore shadows. Emphasize safety: Never look directly at the Sun.

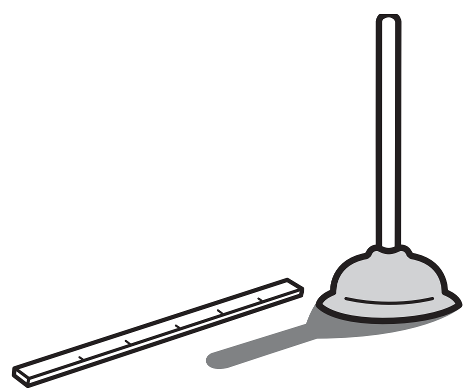
Make the point (over and over during these activities) that it is never safe to look directly at the Sun.

Explain the objective for the field trip: to find out how shadows change over time.

Establish safety rules for working outdoors. These might include:
- Walk. Stay within eyesight of the leader.
- Do not look directly at the Sun.
- Leave the site exactly as you found it.

2. Go outdoors and set up the investigation: How do shadows change over time?

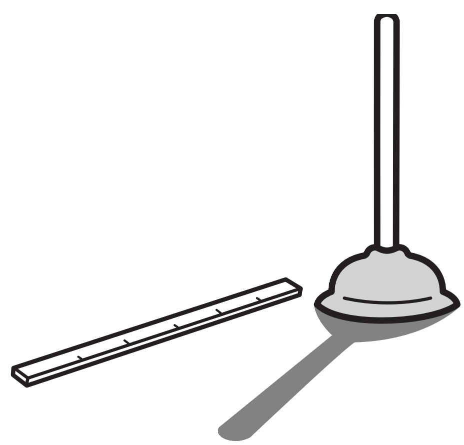
Explain that you will set up the experiment and then leave it in place while you go back indoors to build sundials. Later you will return to find out what happened to the shadow over time.



Take participants to the outdoor site and have them gather around the narrow object (broomstick, yardstick, stake, plunger) which you have selected for the study.

Place a sheet of paper on the ground to catch the shadow. Have a volunteer trace the object's shadow on the sheet of paper. Ask:

- Where is the Sun right now? Without looking at it directly, point to its position in the sky. How do you know that is where the Sun is?



Measure the object and measure the shadow it casts, and note the measurements on the piece of paper. Also record the time. Ask:

- Is the shadow longer or shorter than the object? For participants with the math skills to calculate ratios, you might have them figure out the ratio of shadow length to object height.

5. What Can We Learn About The Sun From Shadows? - Activity

3. Return indoors to construct a sundial.

Distribute the materials and have participants follow the directions on the handout sheets to construct their own sundials. Go over the instructions on the Sundial Handout before returning to the outdoor experiment.

4. Return to the outdoor investigation to see what happened to the shadow.

Outdoors, gather the group around the object casting a shadow on the paper. Have a volunteer trace the new position of the shadow and record the time. Ask:

- Where is the Sun now? Without looking at the Sun, how do you know that?
- Make a prediction: If you came back in an hour, where would the shadow be? In what direction does it move?

Measure the shadow. Ask:

- How has the length of the shadow changed in relation to the height of the object? How might it change in another hour?

5. Use the sundials.

Demonstrate how to use the sundial to track the Sun's position during the course of a day. Suggest that participants take the sundials home and try them out over the weekend when they will have more daylight hours in which to record changes and calibrate their dials.

Ask participants to bring their sundials back to use again in the next science session.

NOTE:
Since it is inevitable that some participants will forget to bring back their sundials, you may need to prepare several extra ones for the next session.

This activity was developed using information from “Telling Time with the Sun” from the NASA for Kids web site.
http://www.nasa.gov/audience/forkids/activities/A_Make_a_Sundial.html

6. Does The Sun Move?

Overview

Participants model the apparent motion of the Sun using a flashlight and their sundials. They discuss the idea that it is the Earth that is moving, and then create a model to demonstrate.

TIME:
- 50 minutes

Big Ideas

- The Sun appears to move across the sky, but things are not always as they appear.
- The Earth rotates from West to East, making the Sun APPEAR to move from East to West.

Connections

Participants have observed shadows and used sundials to track the Sun's apparent motion across the sky. Now they have an experience of modeling events in space by using objects in the classroom.

Materials

- Sundials that participants constructed in the previous session
- 1 flashlight

For each group of 3 to 4 participants:
- 1 styrofoam or clay ball
- 1 push pin, straight pin, or toothpick
- 1 flashlight or other light source such as a lamp or projector
- 1 stick or pencil to use as a handle for the ball

Preparation

1. Darken the room for the activities.
2. Be prepared to provide several extra sundials for those who have forgotten theirs, or ask participants to share.

6. Does The Sun Move?

Activity

1. Model the apparent motion of the sun.

Have participants place their sundials on a table with the tallest part of the gnomons all facing in the same direction.

Ask for a volunteer to use the flashlight to represent the Sun, and to demonstrate how the Sun appears to move across the sky, casting light and shadow on the sundials. Give several volunteers an opportunity to model the Sun's path while the rest of the group observes the pattern of shadows cast on the sundials.

Then ask:
• When you were using your sundials and when we went outdoors during the last session to track the movement of a shadow, how did the Sun appear to move across the sky?

Participants will probably agree that the Sun appeared to move from East to West.

2. Discuss: Does the Sun move?

Invite participants to comment on the fact that you have been talking about the "apparent" motion of the Sun, that it "appears" to move across the sky. Ask:
• Does the Sun really move across the sky?
• Is there another explanation for the pattern we have observed?

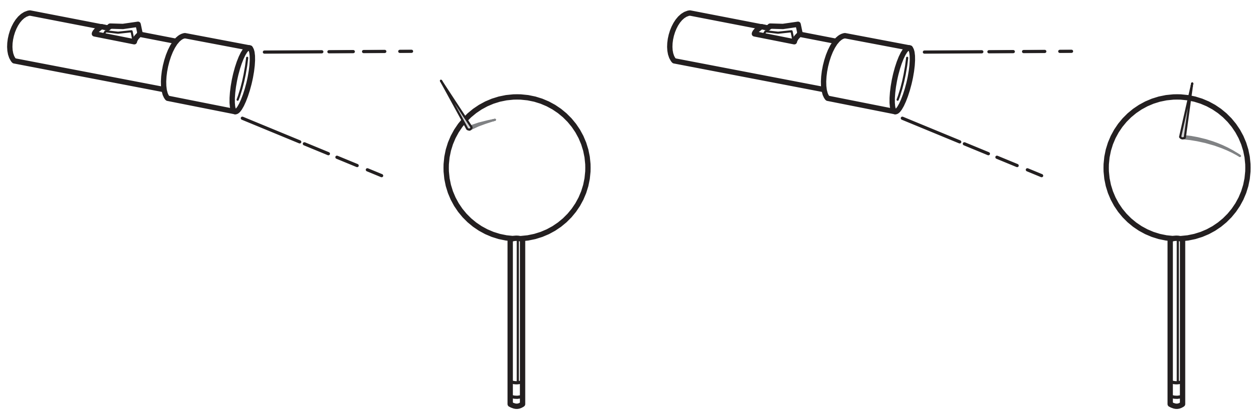
Although this is a difficult concept, many will already know that it is not the Sun that is moving, it is the Earth. Because the Earth rotates from West to East, the Sun appears to rise in the East and set in the West.

3. Challenge: Create a model to demonstrate how the light from the Sun moves across the Earth.

Distribute the balls, pins or toothpicks, and light sources to groups of participants. Have them place the pins into the balls, insert a stick or pencil for a handle, and then use the light source to create a model that shows how sunlight moves across the Earth. Remind them of their investigations with the shadow cast by the narrow object outdoors and of their explorations with the sundials. Ask:

• Can you move the ball relative to the light source so that the shadow of the pin moves the same way the shadow on the playground moved?

When participants are satisfied that they have created a working model, ask small groups to demonstrate.



4. Wrap up: What is modeling?

Explain that what participants have just done is called making a model. It's a technique that scientists use to study things they can't get to and study directly, like the Sun. Models allow you to make predictions that you can then test by observation.

In this model, the flashlight represented the Sun and you could move it about to imitate some things that the Sun does. But other things about the flashlight are obviously different. Ask:

• By using models, what did you learn about the apparent path of the Sun across the sky?

7. How Do Scientists Look At The Sun?

Overview

Participants view live images (or recently printed images) of the Sun taken by the SOHO satellite in a number of different colors of light. They look for differences in the features visible in the different colored light.

TIME:
- 30 minutes

Big Ideas

- Light from the Sun contains all the colors of the rainbow as well as colors that we cannot see.
- Scientists have instruments that can detect light our eyes cannot see. These instruments help us get a more complete picture of the sun in particular, and the universe as a whole.

Connections

This activity draws on participants' explorations of light, and introduces the idea that scientists use the different colors of light given off by the Sun to find out more about it.

Materials

- Either class access to the internet or print outs of recent color images of the Sun from the SOHO website, http://sohowww.nascom.nasa.gov/
- 1 science journal for each participant

Preparation

1. If you do not have group access to the internet, print out recent color images of the Sun from the website listed. Follow the "latest images" link to get to the most recent images of the Sun.
2. It is also helpful to preview information about the features visible in SOHO images available at Windows to the Universe: The Solar Atmosphere http://www.windows.ucar.edu/tour/link=/sun/solar_atmosphere.html

7. How Do Scientists Look At The Sun?

Activity

1. Discuss: How can scientists safely look at the Sun?

Ask participants for their ideas on this question. Then explain that scientists have special telescopes and cameras that allow them to look at the Sun. There is also a spacecraft called SOHO that flies in between the Earth and the Sun. It beams back images of the Sun to NASA and to ESA (the European Space Agency).

2. View images from SOHO.

Either distribute print outs of the images or send participants to the SOHO website at http://sohowww.nascom.nasa.gov/. The "latest images" link on the left takes you to the most recent images. The "classroom" link provides an introduction to what you see in SOHO images at "Our Star the Sun", as well as a definition of terms.

3. Explain the colors in the images.

As participants are viewing the images, explain that each image is taken in a different color. Some of the colors are similar to the colors we saw when we looked at UV light with the bead detectors. Give a brief summary:

- The pictures in the EIT group are taken in four slightly different colors of UV light, the same kind of light we detected with the UV beads. The colors in these pictures are not real. Rather, the telescope detects the light much the same way the UV beads did. Then computers substitute colors that we can see so that we can look at features on the Sun.

- The pictures in the MDI continuum show the Sun in visible light, not UV light. They show all the colors we can see with our eyes.

- The MDI magnetogram pictures show the Sun's magnetic fields.

- The LASCO pictures cover up the Sun itself with a disk. So what we see are jets of light traveling away from the Sun. These jets are called solar flares.

7. How Do Scientists Look At The Sun? - Activity

4. Introduce the science journals.

In their science journals ask participants to record their findings. Prompt them to:

- Compare images
- Describe visible features in each image
- Find images that show correlating features

5. Discussion: Share findings.

Invite participants to share their observations and their ideas about the Sun images.

8. Are All Stars Like The Sun?

Overview

Participants make estimates of the numbers of stars in a segment of the sky, and classify the stars according to their brightness. They then observe colored images of stars. As a final activity, they record their ideas on whether or not all stars are like the Sun, and discuss the importance of studying our nearest star.

TIME:
- 45-60 minutes

Big Ideas

- The Sun is a star like the other stars in the sky, only much closer to Earth.
- Stars come in different colors and sizes, but all are sources of energy.

Connections

Participants think about the Sun as one of many stars rather than as our unique source of light and energy.

Materials

- "Star Image"handout, one copy in black & white and one copy in color for each group of 2 or 3 participants.
- 1 science journal for each participant

Preparation

No advanced preparation beyond the gathering of materials necessary for this activity.

8. Are All Stars Like The Sun?

Activity

1. Share prior knowledge about stars.

Ask participants to share what they already know about stars. Use some of these prompts:
- What do you know about stars?
- How are the stars like our Sun?
- Have you noticed that you can see more stars in the sky when you are in the country than when you are in the city? Why do you think that is so?
- Have you ever looked at stars through a telescope?

2. Estimate: How many stars?

Divide participants into groups of 2 or 3 and distribute a black and white image of stars to each group. Ask them to develop a plan for estimating the number of stars in the whole image without counting every star.

As the groups work, circulate and ask them about their strategies. They may come up with plans such as:
- Divide the image into squares. Count the number of stars in one square. Multiply by the number of squares.
- Divide the image into squares. Count the number of stars in a full square and an emptier one. Find the average. Multiply by the number of squares.

Give each group an opportunity to share their strategies and their estimates. How many stars do they estimate are in their image?

3. Classify the stars as faint, medium, or bright. Record data in a bar graph.

Ask participants what differences they observed in the brightness of the individual stars. Then ask them to pick one or two sections of their star image and classify the stars in that section as faint, medium, or bright. In their journals, have them record their data on a bar graph with the number of stars along the vertical axis and the three categories of brightness along the horizontal axis. If necessary, model a bar graph for the group.

Invite groups to share their results. Then ask:
- What brightness of star is the most common?
- Are there more bright stars or more faint stars?

Ask the participants to think about what causes the differences in brightness:
- Are the brightest stars really brighter than other stars, or do they only seem brighter because they are closer to us?

8. Are All Stars Like The Sun? - Activity

Explain that differences in star brightness can be due both to the actual brightness of the star and how far away it is from us. The actual brightness depends on the size (the larger the star is, the brighter it tends to be) and temperature (hot stars are brighter, cooler ones are dimmer). However, how bright a star appears to be also depends on how far away from us it is. A dim star that is very close to us can appear to be brighter than a bright star further away. The Sun, a medium-sized star, is much, much closer to us than any other star in the sky, and consequently appears to be much, much brighter.

4. Observe colors in stars.

Distribute the colored images of stars and ask participants to describe the colors the see. Ask:
• What colors do you observe?
• Do you notice any patterns in star color and brightness?

Explain that, even to the naked eye, stars vary slightly in color. Star color is connected to the star's temperature. The, hotter stars are bluer in color. Smaller, cooler stars are reddish. Scientists also use spectroscopes to study the light from stars – we can tell what stars are made of by looking at their spectral patterns.

5. Consider the question: Are all stars exactly like the Sun?

In their journals, ask participants to develop a position on the above question. Encourage them to draw and write about their idea, and to give reasons to support their position based on what they have already learned about the Sun.

Give participants an opportunity to share their ideas with the group.

6. Wrap up: Why is it important to study the Sun?

Ask participants to summarize their thoughts on why it is important to study the Sun. Ask:
• What can we learn by studying the Sun?
• Why might it be important to find out more about the Sun?

Explain that the Sun is the only star that is close enough for us to see well. All the others are very far away, and appear just as points of light, even in big telescopes. As we learn more about our own star, we learn more about other stars in the galaxy.

This activity was adapted from *Northern Lights, Solar Sprites* produced by IMAGE Education and Public Outreach Team, NASA Goddard Space Flight Center. http://teachspacescience.org/graphics/pdf/10000151.pdf

Sun Resources

Books

Cooper, Christopher. *Light: From Sun to Bulbs*. Chicago, IL: Heinemann Library, 2003.

Lassieur, Allison. *The Sun*. Danbury, CT: Children's Press, 2000.

Mitton, Simon and Jacqueline Mitton. *The Young Oxford Book of Astronomy (Young Oxford Books)*. New York: Oxford University Press, 1995.

Simon, Seymour. *The Sun.* New York: Harper Trophy Publications, 1989.

Waugh, Albert Edmund. *Sundials: Their Theory and Construction.* Mineola, NY: Dover Publications, 1973.

Websites to Explore

- For images of the Sun from the SOHO satellite
  http://www.windows.ucar.edu/tour/link=/sun/solar_atmosphere.html

- For more images from the SOHO satellite
  http://sohowww.nascom.nasa.gov/
  Look under "Free Stuff" for a downloadable coloring book, "Star Light," that talks about the sun as a star.

- For a free downloadable book from NASA
  English Version: Our Very Own Star the Sun
  http://spacelink.nasa.gov/products/Our.Very.Own.Star.the.Sun/

  Spanish Version: Nuestra Propria Estrella el Sol
  http://spacelink.nasa.gov/Instructional.Materials/NASA.Educational.Products/Nuestra.Propria.Estrella.el.Sol/index.html

Relevant National Science Education Standards

The National Science Education Standards (National Research Council, The Academic Press, Washington, D.C., 1999) relevant to the activities in this educator resource guide are listed below.

As a result of activities in grades K-4, all students should develop understanding of:

Standard B: Physical Science
- Light: Light travels in a straight line until it strikes an object. Light can be reflected by a mirror, refracted by a lens, or absorbed by the object.

Standard D: Earth and Space Science
- Objects in the Sky:
    - o The sun, moon, stars, clouds, birds, and airplanes all have properties, locations, and movements that can be observed and described.
    - o The sun provides the light and heat necessary to maintain the temperature of the Earth.

Standard F: Science in Personal and Social Perspectives
- Personal Health: Individuals have some responsibility for their own health. Students should engage in personal care--dental hygiene, cleanliness, and exercise--that will maintain and improve health. Understandings include how communicable diseases, such as colds, are transmitted and some of the body's defense mechanisms that prevent or overcome illness. *Note: The link to this standard comes from the discussion of UV light and the need for sunscreen.*

Standard A: Science as Inquiry
- Abilities necessary to do science inquiry:
    - o Ask question about object, organisms, events in the environment
    - o Conduct a simple investigation
    - o Employ simple equipment and tools to gather data and extend the senses
    - o Use data to construct a reasonable explanation
    - o Communicate investigations and explanations
- Understandings about science inquiry:
    - o Simple instruments, such as magnifiers, thermometers, and rulers, provide more information than scientists obtain using only their senses

SPECTROSCOPE DIRECTIONS FOR INSTRUCTORS

(For Use with Activity 2)

Spectroscope Pattern #1

This is the easier but less sturdy design. Participants should be able to construct the whole spectroscope with minimal help from the instructor.

MATERIALS

- 1 sheet of heavy dark paper for each participant (construction paper or a manila folder which participants color black or dark blue on the inside)
- 1 CD wedge for each participant (see Preparation below)
- tape or rubber cement
- scissors

PREPARATION

1. Copy the spectroscope template onto the heavy paper.
2. Use scissors to cut the CD (any discarded CD will do) into wedges. See the template for the approximate size. You can get about 16 wedges from each CD. If the CD cracks while you are cutting, heat the CD to soften it before continuing to cut.

Spectroscope Pattern #2

This pattern is more sturdy but requires the instructor to do more advance preparation.

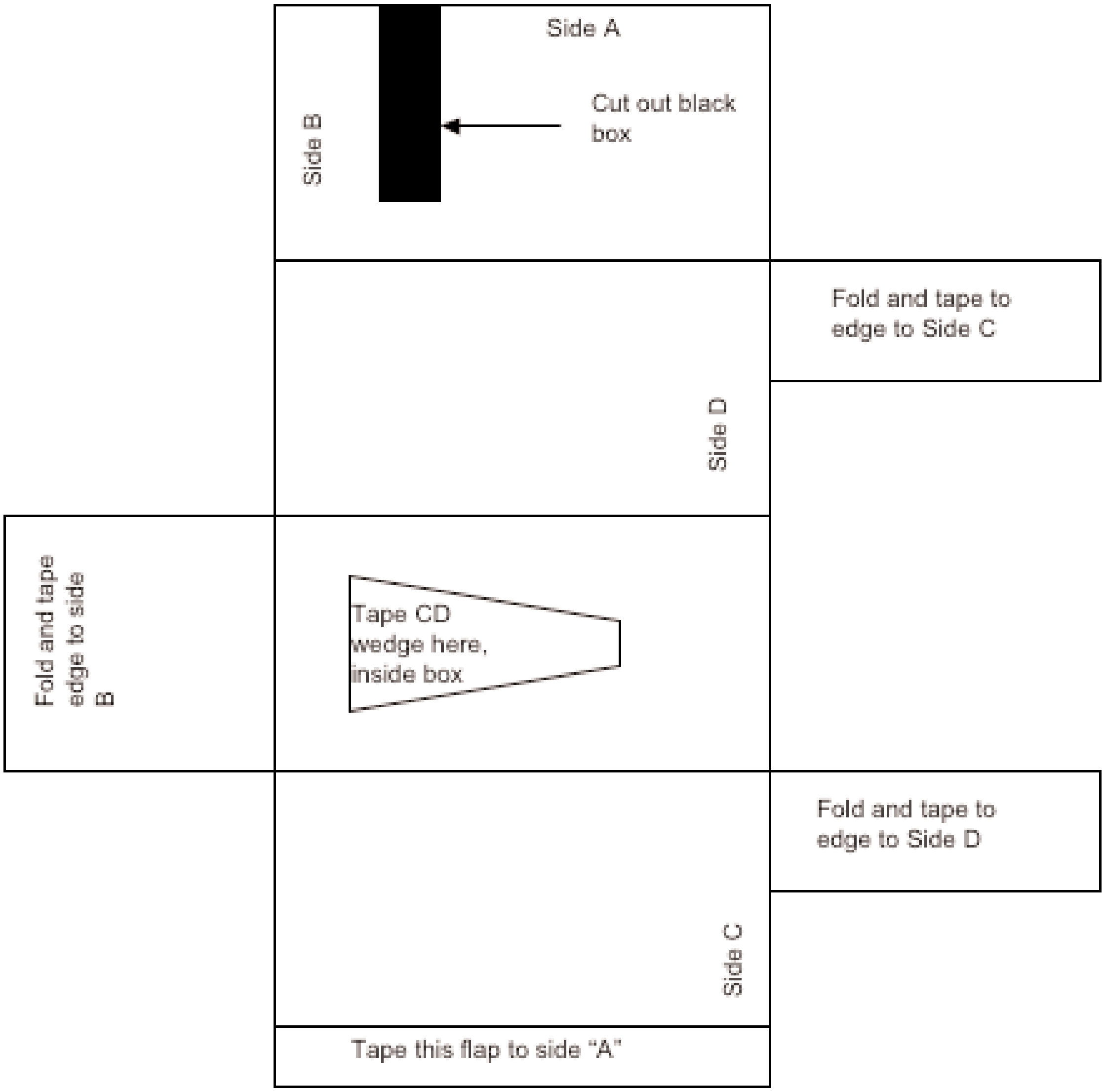
MATERIALS

- 1 toilet paper tube for every 2 participants
- 1 CD wedge for every participant (see Preparation below)
- tape or rubber cement
- scissors
- sharp knife or razor blade

PREPARATION

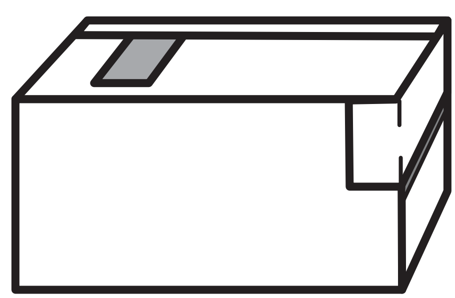
1. Cut each toilet paper tube in half. A sharp knife works best.
2. Use the knife to cut out the viewing hole on the side of the tube as shown in the diagram.
3. Make copies of the two circle patterns.
4. If you think yourparticipants will not be able to do it themselves, cut out the slit in the circle pattern indicated by the dark line. You may use a knife or razor blade.
5. Use scissors to cut the CD (any discarded CD will do) into wedges. See the template for the approximate size. You can get about 16 wedges from each CD. If the CD cracks while you are cutting, heat the CD to soften it before continuing to cut.

SPECTROSCOPE PATTERN 1



Directions for Participants :

1. Carefully cut out the pattern. Don't forget to cut out the black box on side B. This is your viewing hole.
2. Glue or tape the CD wedge inside where shown on the pattern. Cover the narrow end of the CD with tape or scribble over it with black marker. Otherwise it acts like a mirror and your spectroscope won't work well.
3. Fold the pattern on all the heavy black lines.
4. Tape the flap of side C to side A.
5. Tape the solid end flap to side B.
6. The last side of the box is the tricky one. It has two strips, and you will need to leave a narrow space in the middle, between the two flaps for light to enter. Tape one strip of the end flap to side C. Now be very careful to leave a small space for light to enter when you tape down the last end flap to side D.
7. You may need to add more tape here and there to make your spectroscope hold together well.



SPECTROSCOPE PATTERN 2

Directions for Participants :

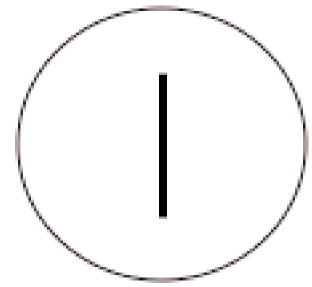
1. Glue or tape the CD wedge inside the tube, opposite the rectangular viewing hole. Cover the narrow end of the CD with tape or scribble over it with black marker. Otherwise it acts like a mirror and your spectroscope won't work well.

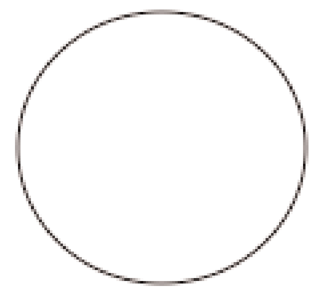
2. Cut out the two circles.

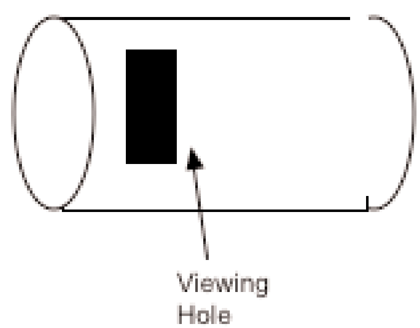
3. Tape the solid circle to the end of the tube closest to the viewing hole.

4. If your instructor has not already done it for you, cut out the slit indicated by a solid black line in the center of the other circle.

5. Tape the circle with the slit onto the end of the tube that is farthest away from the viewing hole. This is where light will enter the spectroscope.

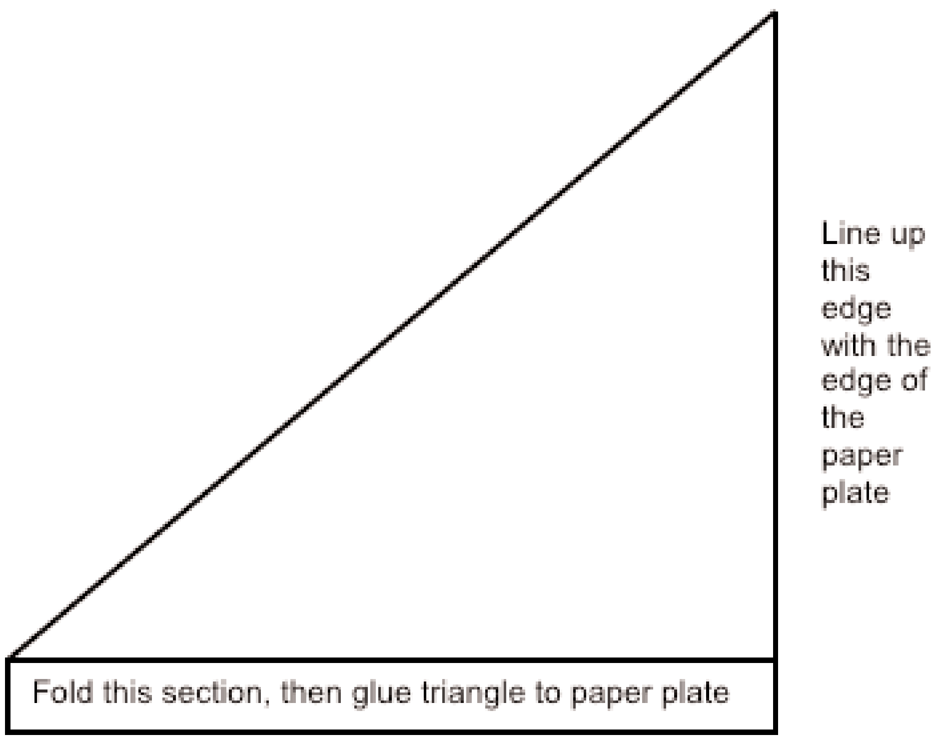






SUNDIAL HANDOUT

Latitudes around 40 degrees



Making the Sundial:

- Cut out the triangle above.

- Glue or tape the triangle to a paper plate so that the taller side is lined up with the edge of the plate and the smaller side points to the plate's center.

Telling Time with a Sundial:

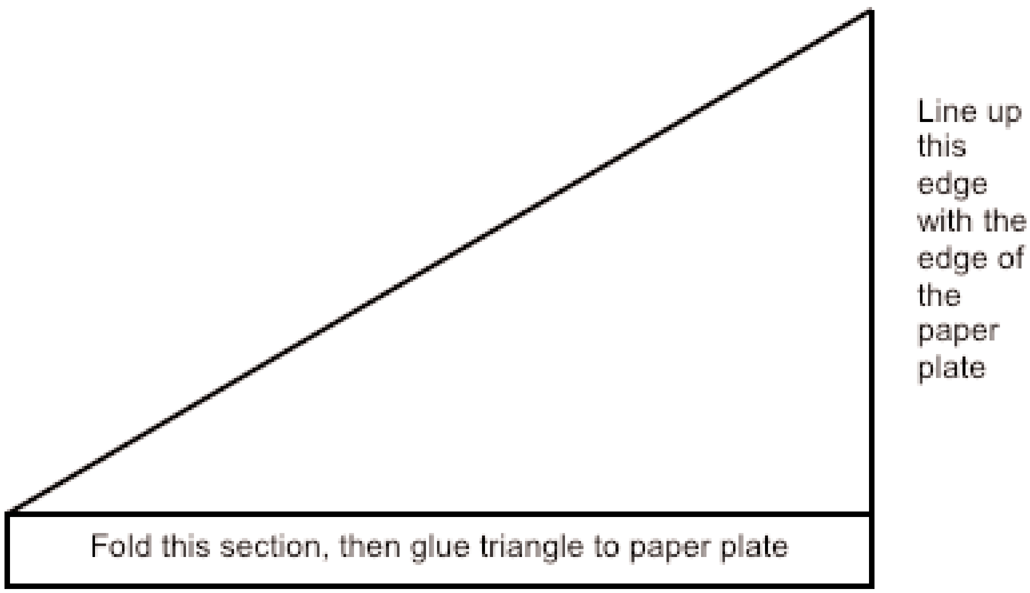
- Take your new sundial outside on a bright morning on the hour (8:00, 9:00, etc.).

- Tape or weight it down so that it doesn't blow away; you should NOT move it from your chosen location. Mark your plate to show the position of the triangle's shadow and write the hour next to it.

- Check your sundial a few more times during the day, remembering to trace the shadow and mark the corresponding hour on the clock. Congratulations, you've made your own sundial!

SUNDIAL HANDOUT

Latitudes around 30 degrees



Making the Sundial:

- Cut out the triangle above.

- Glue or tape the triangle to a paper plate so that the taller side is lined up with the edge of the plate and the smaller side points to the plate's center.

Telling Time with a Sundial:

- Take your new sundial outside on a bright morning on the hour (8:00, 9:00, etc.).

- Tape or weight it down so that it doesn't blow away; you should NOT move it from your chosen location. Mark your plate to show the position of the triangle's shadow and write the hour next to it.

- Check your sundial a few more times during the day, remembering to trace the shadow and mark the corresponding hour on the clock. Congratulations, you've made your own sundial!

STAR IMAGE

(for Use with Activity 8)

NASA/HST